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AND THE RECORDING OF

AMERICAN AND OTHER PATENTED INVENTIONS.

FEBRUARY, 1834.

Remarks on the use of Anthracite Coal in Smith's Work.

By ALFRED C. JONES.

TO THE COMMITTEE ON PUBLICATIONS.

GENTLEMEN,—I have had occasion to observe the facility with which anthracite coal is used for working iron, by the smiths in this part of the country, and as I wish to see it brought into operation in other places, on account of the decided saving resulting from its use, I have supposed it important to give accurate information as to the best method of adapting the forge to its use, and of making the fire. The methods employed successfully in its use by the best workmen are as follows:—

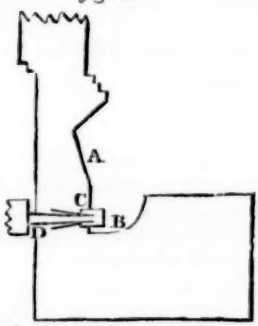
The arrangements of the forge, with the exception of the parts which I shall describe, are the same as where bituminous coal is used. The fireback of the forge for using anthracite, projects at the bottom, at least two inches from a vertical line, as shown by the accompanying diagram, fig. 2, and the bed for the coals is larger for anthracite than when bituminous coals are used. The tuyere iron is made in the form shown in fig. 1; the nozzle A is four inches in length, and three in diameter, and projects out at least three nches from the fireback; the orifice for a thirty inch bellows is one inch and one-eighth in diameter, the nozzle of the bellows extends into the tuyere iron, so that its end is even with the fire-

fig. 1. A

back. In making the fire the common method is to rake out the half burned coal towards the front of the forge, and to separate the cinders from it; then to set fire to a few shavings in the bed, placing on these several blocks of soft pine; to urge the bellows gently until the wood is partly ignited, when the bellows is no longer to be worked: the wood is now covered with fresh coals, when the whole blast may be employed. The half burned coal that was raked out of the bed, may then be banked up against the fresh coal. The best method of keeping the fire uniform is to select a large lump of coal, free from slate, and place it on the front of the forge hearth, and whilst the iron is heating in the fire, to break off small portions, which should never be larger in size than walnuts. It is of considerable importance to use the coal small, as a heat is obtained much quicker by so doing; when the coal is large, a great part of the blast passes through the interstices, and a portion of the labour of the bellows blower is wasted. The body of the fire except on the side next to the anvil, is banked over with the half burned coal, which confines the flame to the top. For common purposes the fire need not be cleaned oftener than three times per day, say at ten A. M., at noon, and at four P. M., when the cinders having been taken out, a few blocks of wood are thrown on, the hot coals raked over them, and the bellows urged until the fire is in a fit state for going on with the work.

In using the poker for the purpose of giving the fire vent, its end should not be put below the tuyere iron, and its motion should be towards the front of the forge, and gently upwards. The tuyere iron may be protected from the intense heat of the fire by occasionally throwing a little of the refuse coal against the fireback, which otherwise would melt down or coat the iron. In the accompanying figure, 2, A is the fireback; B the bed for the coal; C the tuyere iron; D the bellows pipe.

fig. 2.



Where charcoal can be obtained cheaply, it may be used instead of wood for making a fire, but wood answers the purpose quite as well.

Tamaqua, December 21, 1833.

Description of the Furnaces used at the United States Armory, at Springfield, Massachusetts, for Welding Gun Barrels, with Anthracite Coal as a fuel.

We give, in connexion with the foregoing article, the description of the means employed at the Springfield Armory for obtaining a substitute for a hollow fire, with anthracite as a fuel. The drawings of the furnace there used were furnished by a scientific officer of Artillery, Lieut. D. Tyler, who has been engaged for some years in

the inspection of arms manufactured for the United States. The success of this furnace in affording a welding heat, without danger of burning the material, is represented to be complete. Of the drawings received, we have selected a plan and two cross sections, as giving a sufficiently complete idea of the construction of the furnace.

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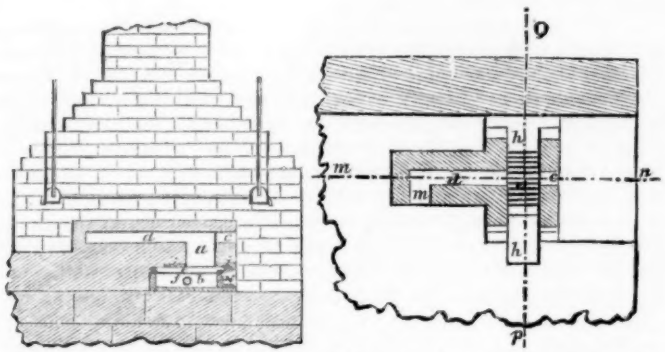
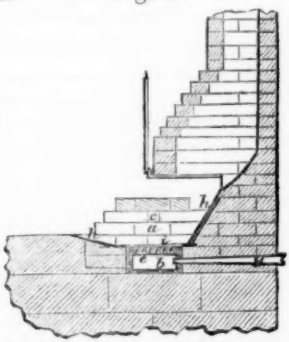
Fig. 2. *Fig.* 1.



Description.—Fig. 2 is a plan, and figs. 1 and 3 are sections of the furnace. The section fig. 1, is on the line *m n* of the plan, and fig. 3 on *o p*, perpendicular to *m n;* the points through which the plane of section passes are shaded in the figure.

Fig. 3.



a, figs. 2 and 3, shows the interior of the furnace; its height being eight inches, its width seven, and the length of the covered part one foot six inches. This covered part is represented by the shaded portion in fig. 3, immediately over the grate.

b, figs. 2 and 3, is a cast iron box or chamber, the sides of which are about half an inch thick. The dimensions of the box are, length one foot six inches, width eleven inches, and depth four inches. The top of this chamber is open for about one foot two inches of its length to receive a fire grate *c*.

c, figs. 1, 2 and 3, represents the grate, covering the chamber just described, the length being fifteen inches, and the width eleven inches. It is composed of seven bars, each one inch in depth; and in width, on the upper surface, one inch, and on the lower surface half an inch.

f, fig. 2, is a movable door, by which to clean the chamber of the ashes and cinders which fall from the grate.

g, fig. 3, is the tuyere, or blast pipe, through which the supply of air to the fuel is introduced.

i, figs. 2 and 3, is a cast iron plate placed horizontally on the bottom of the furnace; a hole is cut through it for the passage of air from the chamber *b* to the fuel upon the grate.

h h, figs. 1 and 3, are two cast iron plates, half an inch in thickness, one of them being placed at each end of the furnace in the inclined positions shown in fig 3.

c, figs. 1, 2, and 3, is an opening two and a half inches high, and two inches wide, through which the gun barrel to be welded is introduced into the furnace; and *d*, figs. 1 and 2, is a recess of the same dimensions in height and width, and one foot ten inches long; its object is to receive the gun barrel, so as to permit the part to be heated to be brought directly over the fire. Into the recess *d*, there is a lateral opening *m*, fig. 1, five inches in width.

The furnace is built of fire bricks, the basis being a common blacksmith's forge. The two ends, as shown in fig. 3, are left open; upon one of them the fireman keeps a pile of coal, which forms a simple and efficient door; the coal is pushed with a poker into the fire, as it requires replenishing, and the pile is renewed.

Note on Astronomical Observations, particularly with reference to a Monthly Statement of Celestial Phenomena, to be Calculated for Philadelphia and its vicinity. *By* Sears C. Walker.

TO THE COMMITTEE ON PUBLICATIONS.

Gentlemen,—It has frequently been remarked that while the natural sciences have been cultivated in this city with a zeal and success unexampled in this country, the science of practical astronomy has fallen into general neglect.

An excellent treatise on practical astronomy, by John Gummere, and several valuable papers in the Transactions of the American Philosophical Society, are nearly all that the press of Philadelphia has furnished in the last fifteen years. During this period many volumes and papers have been published on every subject of natural, medical, and chemical sciences, and practical mechanics.

Theoretical astronomy is taught in all our academies of note, and courses are given every year in all our public lecture rooms. These lectures are as well attended as those on any of the natural sciences. At this time, the course on this subject delivered at the room of the Franklin Institute by a gentleman distinguished for his attainments in astronomy, is listened to by a crowded audience.

We should not be astonished that a study so classical in its nature has numerous votaries; but we may be surprised that its practical applications should be neglected.

Yet within a few years the occultations of Venus, Jupiter, Saturn,

of Aldebaran, the transit of Mercury, and the solar eclipse of 1832, have passed away almost unnoticed, or which is nearly the same, the observations which have been made have been kept from the world.

I must here remark that the annular eclipse of 1831, was observed with a zeal whose rarity enhances its value.

It could not have been expected that a study which for fifty years took the lead of all others, should become so nearly obsolete; when in a neighbouring city it is still cultivated with untiring zeal. From the press of that city we are furnished with the means of interpolating between Boston, Mass., and Charleston, S. C., the times of interesting celestial phenomena visible in this place.

It has been supposed by some that the deficiency of apparatus has caused this neglect. I believe that this opinion is erroneous; for the means of making observations have been constantly increasing.

There are in the city, or in its immediate neighbourhood, four telescopes, as good as those used in the Royal Observatory of England for making observations of solar eclipses, lunar occultations, and eclipses of Jupiter's satellites. There are besides four achromatics of three and a half feet focal length, three Gregorians of equivalent magnifying power, and several thirty inch achromatics.

It is worthy of remark, that observations with the last class of thirty inch instruments, are eagerly collected and published in the Transactions of the Royal Astronomical Society of London. Chronometers and astronomical clocks are possessed in abundance by individuals; and there is in this city a manufactory of clocks and chronometers, of high reputation at home and abroad.

For rating these chronometers, a sextant would suffice in the hands of a careful observer; but there are four transit instruments either in perfect repair and adjusted to the meridian, or susceptible of repairs and adjustment by mechanical means, in the possession of individuals in this city.

It would seem that it is not the want of instruments which has retarded the progress of this study, for there are several individuals, in this city, better furnished with instruments than was Olbers when he made two discoveries of new planets, either of which will form an era in the history of his native country.

No one, I believe, will maintain that enough has already been done in practical astronomy here; or that additional observations would be useless. The longitude of this place is not completely determined, and were it so, the greater would be the need of accurate observations for correspondence with others made in every section of the country.

A century of observations at the London and Paris observatories, had not determined their difference of longitude with accuracy sufficient for the demands of science in England and France.

It will be a long time before accurate observations will be accumulated in this country to such a degree as to become superfluous. I may rather say, that such a period will never arrive.

It has been found by experience, that the circulation of predicted lunar occultations, and similar phenomena, in the European journals, has done much to promote the cultivation of this useful study.

With a hope that the possessors of astronomical instruments will be disposed to make observations, and publish them in the Journal of the Franklin Institute, or in some other journal, or transactions, I send you a list of the lunar occultations of the fixed stars to the seventh magnitude, inclusive, visible in Philadelphia, in the month of March; together with the eclipses of Jupiter's satellites, and other interesting celestial phenomena. These will be continued in future numbers,* if they meet your approbation, and accomplish the purpose for which they were intended.

I am, gentlemen,
Yours truly and very respectfully,
S. C. WALKER.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Analysis and observations on divers Mineral Substances.

By THOMAS G. CLEMSON.

[Read before the Geological Society of Pennsylvania.]

There exists, near Philadelphia, on the land of Dr. Parrish, considerable quantities of a substance which has the following properties. It is found in amorphous masses, of a dark brown colour, having an earthy fracture, may be cut with a knife, which gives a waxy or resinous lustre to the parts separated, a lustre which may be obtained more perfect by burnishing. It is susceptible of being reduced to an impalpable powder. The vestiges of vegetable fibre have not yet entirely disappeared from it, proving its vegetable origin. When exposed to heat, the ordinary products obtained from organic distillation, are given off.

Ten grammes of a portion previously dried to 100° centigrade, (212° Fah.,) were calcined in a close crucible, the loss in water and bituminous matter, was 3.4 grammes. The remaining 6.6 grammes, were then heated, and at the same time exposed to the air. The earthy residuum weighed 5.57 grammes. From this, the composition in parts of unity is as follows:—

Volatile matter, .	0.340
Carbon . .	0.103
Cinders . . .	0.557
	1.000

The cinders, or earthy matter, left after roasting were coloured of a reddish orange hue, owing to the presence of a little oxide of iron: it might thus be employed as a pigment. When in its natural state, and pulverized, it gives a fine brown colour, with all the intermediate shades between a dark and light brown, and may be used with glue

* This table for March, will be found by our readers at the close of this number. COM. PUB.

or with oil, either of them drying and covering well. After calcination in close vessels, it is perfectly black, and might be used as a black for ordinary purposes, being peculiarly well adapted, when properly mixed, to the coating of iron for preventing oxidation, to ship painting, or the various applications of black pigments used in dressing ships. The small portion of carbon, and the excess of earthy matter, will be obstacles to its being employed as a combustible; however, experiment may prove its utility for burning lime, bricks, and in those cases where slow evaporation is required. A use which might grow out of its property of taking a polish under pressure and friction combined, would be that of painting paper, as a varnish upon stained papers very much increases their value. This matter might be employed to colour, and, being susceptible of a lustre, would not require a varnish. The polish upon the French playing cards is obtained by rubbing the card with a little Marseilles soap, and then burnishing.

If employed alone, as a manure, it would not be attended with ameliorating effects, owing to its inalterability, but in a compost mixed with dung or lime, in the proportion of about one part of either of these substances to four or five of this matter, a fermentation would most probably ensue.

Another specimen of a perfectly similar substance was handed me for examination by Capt. Wm. Pell, and is found on his farm near New York, possessing all the properties of the preceding, save that the vegetable fibre in this case has entirely disappeared; like the former, it gives off the characteristic odour of peat when burning. It contains—

Volatile matter . .	0.201
Carbon	0.030
Cinders , . . .	0.769
	1.000

The ashes were of a dirty gray colour; the preceding observations are probably applicable to this second substance.

Assay of an Iron Ore from Franklin county, New York, found upon the land of Mr. H. B. Pierpoint.

This mineral has a crystalline texture; its colour when in mass is black, and when reduced to powder, greenish brown. It has a slight action upon the needle, without possessing evident marks of polarity; has a soft and somewhat of a resinous lustre; is soluble in muriatic acid, with but a trace of insoluble residuum.

Twenty grammes of ore, and six grammes of borax, were submitted to an assay heat, in a crucible; the result of the assay was a black transparent scoria and a button of iron, weighing together 15.52 grammes; the iron alone weighing 12.90 grammes.

From this assay, this ore contains 64.50 per cent. of iron, having a fine texture, and is similar to steel in many of its properties.

Analysis of two varieties of Hydraulic Limestone from Virginia.

The blue limestone formation is of considerable extent in Jefferson county, Va. It runs from the Shenandoah river through Charlestown, dipping at various angles, to the Potomac, and finishes on the river a little below Shepardstown, at a locality called Butler's Mills, in several noble bluffs. The stratification is here very much inclined. The mass of the rock has a light blue colour, from which it takes its name, and is divided by veins of a limestone differing from each other, and from the mass in colour as well as in chemical constitution. Several varieties are quarried, and give, after calcination, hydraulic cement of fine quality, much of which has been employed on the Ohio and Chesapeake canal, and in the neighbourhood, for cisterns, and a variety of other hydraulic purposes.

I analysed two varieties of this limestone, the one was of a black colour, had a conchoidal fracture, and was susceptible of a fine polish, differing from the gray variety, inasmuch as the latter contains a greater proportion of alumina, giving the hydraulic properties, and is free from bituminous matter, the evident cause of the black colour observed in the first. These two substances being found in immediate contact with the blue limestone, I add an analysis of this rock from the same locality.

Black Limestone.		*Gray variety of Limestone.*	
Alumina	0.152	Alumina	0.326
Magnesia	0.082	Magnesia	0.026
Oxide of iron	0.014	Oxide of iron	0.020
Carbonic acid, water, bitumen	0.392	Lime	0.330
Lime	0.360	Carbonic acid and water	0.298
	1.000		1.000

Blue Limestone.

Alumina	0.048
Lime	0.512
Carbonic acid and water	0.414
Other substances, oxide of iron, &c.	0.026
	1.000

On the Dew-point Hygrometer in connexion with the Wet Bulb Thermometer.—By James P. Espy.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

The interest which observations upon the dew-point are now exciting throughout the scientific world, induces me to introduce the subject again to the readers of this Journal; particularly as I have made observations on the wet-bulb thermometer in connexion with the dew-point constantly for many years.

These observations were instituted with a hope that some law might be established by which the dew-point might be calculated—the temperature of the air and the temperature of the wet-bulb being given. I entered upon this investigation with more hopes of success, as I found it stated by Mr. Leslie, in the Supplement to the Encyclopædia Britannica, (art. Meteorology, if I mistake not,) that the ultimate temperature of a thermometer, surrounded with a wet rag, was the same whether it was placed in the wind, or in still air; and that the time alone in which it was cooled down to this point was affected by the velocity of the wind. In my first observations on these two instruments combined, I took this law for granted, as it was announced by such high authority, and accompanied by a very plausible explanation; but I had not proceeded very far before I perceived such discrepancies in my observations, as induced me to doubt the truth of Mr. Leslie's statement, and I immediately proceeded to test it by actual experiment.

I placed a naked thermometer, and one surrounded with a wet rag, near each other, in still air, where I let them remain until that with the wet bulb sunk as low as it would by evaporation below the temperature of the air; I then swung them both rapidly in the air together, and in all experiments of this kind which I have made, and they are very numerous, the thermometer with the wet bulb has fallen when swung, and risen again when at rest in still air. The quantity of depression varies with the distance of the dew-point below the temperature of the air; I have seldom in the middle of the day found it less than one degree, and have frequently seen it four degrees. I have found it absolutely necessary to swing the naked bulb with the wet bulb, otherwise very erroneous results will be obtained from the effects of radiation, as will appear by the two following experiments:

November 24th, 1833.

Temperature of naked bulb in still air,		67° Fahr.
Do.	do. swung rapidly	70° do.
Do.	wet bulb in still air	57° do.
Do.	do. swung rapidly	54¼° do.

November 26th, 1833.

Temperature of naked bulb in still air		70° Fahr.
Do.	do. swung rapidly	76° do.
Do.	wet bulb in still air	59° do.
Do.	do. swung rapidly	57° do.

The dew point in the first experiment was	38°
And in the last it was	35°

These experiments were made in a room where the walls were evidently colder than the air in the inside; for the naked thermometer in one of them, when swung, rose three degrees, and in the other six degrees, above the temperature indicated when at rest. If the wet bulb alone had been used in these experiments, it would have appeared by the first that it sunk by motion only, two and a half degrees, and by the second only two degrees; whereas by the aid of the naked bulb, it appears that the effect of swinging was in the first case five and a half degrees, and in the last case eight degrees.

The correctness of this deduction is rendered probable by an experiment on the 27th November, 1833, in which the wet bulb sunk on being swung from 62° to 55°, the naked bulb in both instances being 74°.

It is hoped that these observations will meet the eye of the meteorologists of Great Britain, who are now pursuing this subject with intense interest. It will free them from many embarrassing discrepancies in their observations made with a view to ascertain the relation which the three points of temperature under discussion have to one another.

It is manifest that this relation never can be discovered if the observations are made indiscriminately in the wind and in the still air.

The incorrectness of the assertion made by Leslie on this point, was shown by the writer of this article, in this Journal, in the year 1831, vol. vii.

It would appear, however, from the following passages in the second report of the British Association for the Advancement of Science, that it has escaped the notice of the members of that most respectable body:—

"Great as are the advantages of the simplicity of calculation with the dew-point experiment, there is a less direct experiment, which offers great facilities in performance, and likewise the means of self-registration. I allude to the moistened bulb hygrometer, in which the coolness produced is a function of the dryness of the atmosphere, *without bearing any relation to the force of wind or other circumstances which affect the rate of evaporation.*" Page 242.

Again the report goes on to say, in page 239—

"Saussure was not aware of the fact that *the coolness produced by evaporation of water from porous bodies, was independent of the rate at which the moisture was carried off by currents of air*—a want of knowledge which gave him much trouble."

Again, in page 248, the report on meteorology says,—"We cannot propose to meteorologists a finer problem for complete solution than that of the moist bulb hygrometer; which will require a close analysis of all that has hitherto been done on the subject. M. Gay Lussac who has communicated some valuable observations towards its attainment, thought it would never repay the labour of complete investigation. In the present state of science, however, we look upon

it otherwise, and feel strongly assured, that in a few years, the more direct method of the dew-point will be banished altogether."

I have not seen Gay Lussac's observations on this point, and we are not informed in the report how they were conducted, but from the experience of three years constant attention to this point, I am inclined to agree with Gay Lussac, especially in observations made at low temperatures.

To show the correctness of this conclusion, I have extracted from my journal a number of observations embracing a great range of temperature. By these extracts it will be seen that the discrepancies of similar observations are so great that it will be utterly useless to attempt, in low temperatures, to substitute the wet bulb hygrometer for the dew-point hygrometer unless a means can be found out to make the observations more nearly agree with one another. These observations were made in the open air, the wind sometimes blowing hard, and sometimes nearly calm, and this may be, in part, the cause of the discrepancies. But I am pursuaded that independent of this, the distance of the *iced bulb* temperature below the temperature of the air, when the dewpoint is down near zero of Fahr. is too small to afford any certain means of calculating the dew point from it, and the temperature of the air, even when the source of error above pointed out, is avoided.

These remarks, however, will not apply to the summer half of the year, and if a law could be discovered by which the wet bulb could be substituted for the dew-point hygrometer, even for half the year, a great advantage would be gained by the meteorologist.

There is another source of error which will cause great discrepancy in the results of different observations, if it is not guarded against, and that is, as I have frequently observed that the dew would not settle on the glass until it was cooled down four degrees below the dew-point, which was ascertained by cooling it down very gradually until it began to settle, and then wiping the glass very dry, and gradually letting the temperature increase, wiping off the dew very carefully as soon as it became visible, until it finally ceased to settle, the last temperature at which it was seen to settle, as the temperature of the glass was increasing, was frequently observed to be four degrees above the temperature at which it first settled.

I have also frequently seen the temperature of the wet bulb five degrees Fahr. below the freezing point without congelation, but upon touching the wet rag, congelation commenced, and the temperature immediately rose to 32°.

I intend this winter, during very cold weather, to use a ball of snow, as well as the wet rag for the moistened bulb hygrometer, and if I obtain results more accordant, I will lay them before the public.

Year.	Month.	Day.	Temp.	Wet bulb.	Dew Point.
1833	March	8	130*	76	28
1831	June	1	90	70	60
do.	July	19	89	73	64
do.	do.	20	89	75	68
do.	do.	23	89	76	70
do.	do.	31	87	78	73
do.	June	20	87	73½	68
do.	July	5	84	74	68
do.	do.	24	84	71	65
do.	June	12	84	71	64½
do.	do.	22	84	66½	55
1832	do.	15	84	77	73
do.	July	5	84	70	57
do.	do.	19	84	72	62
1831	do.	7	81	67½	59½
do.	do.	8	81	63½	52
do.	do.	13	81	71	66
do.	August	3	81	73	68
1832	May	19	80	70	65
do.	June	21	80	66	49
do.	August	21	80	70	62
1831	June	27	76	66½	61
do.	do.	15	77	70	65½
do.	do.	28	76	71	68
do.	August	6	76	64	55
do	July	9	76	72	70
1832	May	16	77	62	50
1833	April	1	68	50	28 40
do.	do.	2	71	55	32 39
1832	March	25	72	58	44 44
do.	May	10	70	56	34
do.	June	1	71	58	45
do.	do.	8	71	65	57
do.	do.	9	70	63	56
do.	do.	20	71	58	45 45
do.	September	1	71	61	49
do.	do.	3	71	65	60
do.	do.	25	65	55	45
do.	do.	13	64	54	44
1833	April	26	64	50	33 31
do.	May	3	65	49	28 37
do.	March	20	63	61	59
do.	April	6	63	48 51 Still air	23 40
do	do.	7	60	52	42
do.	March	22	61	50	37½
do.	do.	31	63	49	24 39
1832	November	30	56	52	48
do.	do.	26	54	46	38
do.	do.	10	53	44	31

* Artificial.

Year.	Month.	Day.	Temp.	Wet Bulb.	Dew Point
1831	October	28	55	45	33
do.	do.	29	53	44	34
do.	do.	30	56	48	39
do.	do.	22	54	52	49
do.	November	4	56	50	43
do.	do.	9	57	52	45
do.	do.	2	50	44	36
do.	do.	17	50	43	33
do.	do.	14	51	44	35
1832	do.	23	49	43	33
do.	do.	17	51	48	44
do.	October	29	51	42	31
1833	April	13	50	40	20
do.	do.	24	50	44 fresh.	34
do.	March	10	50	44 calm.	27
do.	January	4	51	47	37
do.	do.	3	49	45	40
1832	do.	14	51	43	31
do.	do.	15	51	43	32
do.	do.	16	49	43	35
do.	do.	17	47	43	37
do.	do.	20	48	41	29
do.	February	4	47	45	42
do.	do.	28	48	42	33
do.	do.	13	40	33	19
do.	do.	10	40	36	29
do.	January	21	42	37	30
1833	March	13	40	33	20
do.	do.	14	41	32	14
do.	do.	23	44	40½	34
do.	do.	7	38	32	18
do.	February	14	34	31	20
do.	do.	26	36	32	18
do.	January	26	35	30	10
do.	do.	29	34	31	16
do.	do.	29	29	26	12
do.	February	3	30	28	10
do.	do.	21	33	31	9
do.	January	12	23	20	2
do.	do.	11	20	14	— 3
do.	do.	16	24	20	— 2
do.	March	3	22	21	+ 2
do.	do.	4	20	19	— 2

Nov. 24, 1833	Temp. still air 67	Wet bulb, still air 57	Dew point 38
	do. swung 70	do. swung 54½	
Nov. 25.	do. still air 70	do. still air 59	Dew point 35
	do. swung 76	do. swung 57	

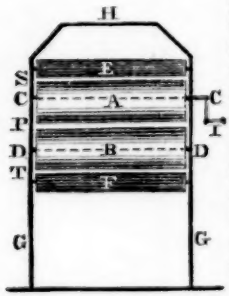
On Printing by Cylinder or Roller Presses.

TO THE COMMITTEE ON PUBLICATIONS.

Alps, Nassau, Rensselaer county, N. Y., Dec. 23, 1833.

GENTLEMEN,—Having given considerable attention to the examination of printing presses, and to their present manner of construction, operation, and execution, for the purpose of devising some more general and eligible plan than any now practiced, or at least some useful improvements, I now send you the result of my inquiries and reflections, desiring you to lay them before the public in the next number of the Journal of the Franklin Institute. It is my intention to prosecute them experimentally as soon as time and circumstances will permit. Perhaps, in some of my suggestions I have been anticipated; nevertheless the principles I have discovered, seem to me to be original and if reduced to practice, highly important. The importance of printing, as a means of multiplying information, so as to be diffused with facility and expedition to all parts of the world, is now generally recognised.

Fig. 1.



I proceed to illustrate by diagram and description, the principles of my theory of printing. In figure 1st. G H G represents a strong upright, and heavy frame, whose size, height, weight, and strength, must be proportional to the dimensions of its cylinder, A B E, and F. A and B represent two hollow or solid cylinders, of equal dimensions, both of whose superfices are to be set all round with movable types, or covered with curved metal plates. C C and D D represent the axes of the printing cylinders A and B. E represents the inking cylinder of the printing cylinder A; and F that of B. S, represents the space between the inking cylinder E, and the printing cylinder A. P, that between the printing cylinders A and B, between which the paper to be printed is to be run; and T that between the printing cylinder B and the inking cylinder F. I represents the handle by which the press is moved, by revolving, and is immediately connected to the end of the axis of the cylinder A. The four cylinders E, A, B, and F, are to be so connected at their extremities by cogged or grooved wheels, that by turning any one of them the whole will be moved. Their axes are to be so set in their frame G H G, by means of springs, screws, wedges, or slides, that they will admit of being set, so as to answer the various thicknesses of paper. Both of the printing cylinders A B being set with movable types, and the inking cylinders E, F, inked, and all set to answer the thickness of the paper, the handle I is to be turned round once, which will ink the types of the printing cylinders A, B, and then the paper to be printed being placed on a table of a height nearly equal to the space P, between the printing cylinders A B, is to be drawn through, which will be effected by the revolution

of the cylinders, in the same way that sheets of metal are drawn between rollers; this operation will print both sides of the paper.

Having described the cylinder press, and the manner of its operation, I will suggest a few particulars in its construction. It is evident that the faces of all the types must be curved, so as to answer the dimensions of their cylinders; that there must necessarily be spaces between the types to fasten them to their cylinders, and between their faces, to make the impression requisite for printing; and that where both the sides of the paper are being printed at the same time, some of the types in one of the printing cylinders may be pressing directly over these spaces, and consequently, unless the paper is very thick, will make an imperfect impression, if not tear or injure the paper considerably. Perhaps the like obstruction would remain even if the cylinders were covered with curved, stamped metal plates or stereotyped. To obviate this obstruction, or disadvantage, which seems to be the primary one, the relief or prominence of the letters on the types, or of the spaces between them, should be as small as possible. As every revolution of the cylinder will produce an impression on both sides of the paper, printing equally, and at the same time, copies can be multiplied as fast as the handle I, can be turned, and consequently from ten to forty impressions per minute may be obtained. Even if only one of the printing cylinders A B were set with movable types, or covered with curved, stamped, metal plates, the other being covered with some elastic substance, an impression would be given on one side of the paper at each revolution of the cylinder, and although two revolutions would thus be required to print both sides, this method might supersede the common one. The inking cylinders are intended to make two or three revolutions, or even more, to one of the printing cylinders, and to be supplied with ink from reservoirs fixed above, or on one side of them; so that the cylinder press may be worked constantly for hours, or days, or even weeks, and copies multiplied until the faces of the types are worn off.

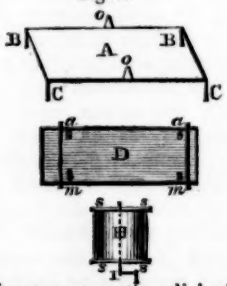
There may be various modes of setting movable types in cylinders and of fastening them; for example, the types may be tapering one way, and be screwed in tight; or may be square, and wedged in by wedge-like slips of metal as long as the cylinders, fastened at both ends thereto, and laying between them just so as to leave the letter of the type above. To obviate the necessity of type setting, which may probably be attended with some difficulty, the cylinders can be covered with curved, stamped, metal plates, as long as the cylinders, and either wide, or narrow, as practice shall determine to be best; these can be easily fastened to them by screws, slides, or nails. Such metal plates should be stamped, either before or after their attachment to their cylinders, so that the letters, figures, &c. on them will be as prominent as if the cylinders were set with movable types. This can be effected, as the plates of metal must be both ductile and malleable, by having them, when drawn out and smooth, placed on some even and hard surface or substance, where every letter can be stamped separately by stamps of steel or other hard and tenacious substance. The dimensions of the cylinder in this press, may be such

as to print at one revolution a volume of a thousand or more pages, the paper being of sufficient size, as one half may be set in type on one cylinder, and the other half on the other cylinder. The pressure between the cylinders can be increased or lessened at pleasure by bringing their faces nearer together, or removing them farther apart, by means of their setting screws, slides, &c., and thus can be made to answer all thicknesses of paper, as well as degrees of pressure.

The distinguishing characteristics of the cylinder press are, the simplicity of its construction, the regularity and uniformity of its motions, the rapidity and facility of its operations, and the equality of its pressure.

Havingdescribed the cylinder press, and suggested some particulars of its construction, I will now proceed to describe the rollerpress.

Fig. 2.



In fig. 2, A represents the frame of the roller press, which is to be made strong, and to be fastened in its place. B B C C represents its legs. D represents the carriage of the types, which runs, or moves, on very finely polished rollers *a m*, *a m*, movably attached to its under side, which are calculated to move or run directly backwards and forwards, between the legs B B, C C, immediately under the frame of the press A, on a level platform or smooth polished surface. *s s s s* represents the two longest sides of the carriage D of the types, which are to be toothed or grooved so as to answer to the teeth or grooves in the extremity of the cylinder H, which is calculated to give the desired impression. H represents the cylinder, which communicates the pressure, and which should be very heavy, covered with some elastic substance, and toothed, or grooved, to answer to the teeth or grooves *s s s s*, on the upper sides *a a m m* of the carriage of the types. I, is its handle, *s s s s* represents its toothed or grooved extremities: *o o* are the standards of the frame of the press, which sustain the supports of the axis of the cylinder H. The frame A being fixed, and the pressing cylinder H made to run or move in its standards *o o*, so as to move the carriage of the types, D, mounted on their rollers, *a m*, *a m*, directly backwards and forwards, between the legs B B C C, by means of their cogs or grooves. The handle I, is to be turned only partly round, and then backwards, so as to make all the types in the carriage D come so directly under the cylinder that the paper intervening will receive a sufficient pressure to be printed. The types in the carriage D are to be inked by inking cylinders, and hung to the frame A, by separate standards, and moved in the same way with the pressing cylinder H, and fixed so as to revolve just above them. The paper is to be laid on the types of the carriage D, to be printed, and when printed, taken off by the hands, while it moves backwards and forwards under the pressing cylinder. This press prints but one side at a time. The roller press can be made to print both sides of the pa-

per at the same time, by having the pressing cylinder H set with movable types, or covered with stamped metal plates, in the way already described for the printing cylinders of the cylinder press, and by having an inking cylinder attached to it to ink it. One side of the paper will be printed by the movable set types or stamped types on the cylinder H, and the other by those in the carriage D. Instead of the cylinder H being fixed, it can be rolled over the types; the carriage in which the types are set, being stationary and steadfast. With regard to the superiority of the cylinder over the roller press, as to construction, operation, and execution, there probably can be no rational doubt. Presses made on the principle of their construction, can be made to answer the size or dimensions of any paper, or even any number of papers, by having the cylinders enlarged and lengthened sufficiently.

Yours respectfully,

H. Strait.

FRANKLIN INSTITUTE.

Monthly Meeting.

The fourth monthly meeting for conversation on mechanical subjects, was held at the Hall of the Institute, on Thursday evening, December 26, 1833, when a model of the ingenious platform weighing machine, patented by Mr. Fairbanks, was submitted for examination. This machine is described at page 399, vol. xi., of this Journal.

Mr. Thos. W. Harvey, of New York, explained by reference to a model, a toggle joint press, invented by him, and intended to be applied to coining.

S. C. Walker exhibited a modification of a portable transit instrument, made originally by Jones, of Liverpool.

The object glass had been made to slide by rack-work, constructed by Mr. Young, mathematical Instrument maker of this city. The advantage of this change was stated to be, that the spider lines are liable to be less broken, as the focus is adjusted without disturbing the eye piece.

The spider lines having formerly been broken, Mr. Young had substituted new ones on a new piece of brass, divided by himself. The intervals between the spider lines had been found by repeated trials to be very nearly equal. The cylinders of the transverse axis had been turned anew, and were found to require no correction for bias of the instrument on reversing the axis.

Mr. Walker mentioned that two instruments on a similar plan were about to be constructed by Mr. Young, and that, judging from the manner in which these adjustments had been made, he had no doubt that they would be as good as those which are imported.

Reports of the Judges of the articles exhibited at the Eighth Exhibition of Domestic Manufactures; held by the Franklin Institute in October, 1833.

[Made to the Committee on Premiums and Exhibitions.]

Report of the Committee of Judges on Philosophical Apparatus.

The committee of judges appointed to examine the articles of philosophical apparatus, deposited at the exhibition just closed, congratulate the committee on premiums, upon the increased number and variety, and upon the improved execution, of the articles of philosophical apparatus exhibited, when compared with the deposits of the last exhibition. This branch of the mechanic arts is rapidly advancing, and the increased demand for its products, cannot fail to stimulate those who are now engaged in it to extend their range of business, and, perhaps, to induce others to embark in some of the various branches yet unoccupied. It will be of incalculable advantage to the cause of science, and to the improvement in instruction in the physical branches of education, that instruments for research and for illustration shall be at hand, and shall be procurable upon terms which may bring them within the reach of the, comparatively, limited means of many. The committee offer these remarks as explaining the details into which their report enters. In remarking upon the articles, the order of the list furnished to the committee will generally be pursued, this being understood to have been the order in which they were deposited.

Three globes, (terrestrial, celestial, and with an ivory surface,) by Josiah Loring, Boston, Mass.

These globes were carefully examined, that with the "ivory surface" attracting most attention; it is intended to teach students to trace the outlines of countries, &c. upon the sphere itself; the principal circles are permanently drawn for reference, and the tracing, when executed in pencil, is readily removed, by washing, from the surface. The other globes are creditable to Mr. Loring, the execution of the maps is good, their covering of varnish remarkably smooth, and transparent, and the mounting generally well executed. In both the globes, there is an irregularity of motion by which the points in the lines traced for the circles change their position in latitude, as marked on the brazen meridian, when the globe is turned upon its axis; a defect which should be carefully guarded against. The committee recommend that honorary mention be made of these globes.

Movable planisphere, deposited by T. T. Ash, intended for the use of schools.

Dial for a clock, by Thos. V. Blackmore, of Philadelphia.

Two pairs of scales for apothecaries, by Joseph Marshall.

Of these, one was a well finished pair intended for common use on the counter, the other, a balance for the more delicate operations of the druggist's shop. As a premium was offered for a delicate balance for apothecaries, the latter instrument was duly ex-

amined. In exterior finish and arrangement, it was superior to an instrument presented by the same maker two years since, but on trial it was not found as sensitive as the balance just referred to. The committee consider that this last point was the one to be particularly attended to, and that no attention to exterior finish merely, would justify them in recommending the award for the premium offered: this should be well understood, and, if the premium be renewed, attention called particularly to the perfection of the working parts. The balance examined had been for some time in use, and allowance should be made for this fact. The committee recommend an honorary mention to be made of the workmanship of Mr. Marshall.

Ecliptico planetarium, by James Swaim.

A box of mathematical instruments, by J. Millington.

Three models of steam engines, by J. Millington, the first, the model of a high pressure engine, the second, of a low pressure engine as made by Maudesley, of London; the third, a Boulton & Watt low pressure engine. The execution of these models was remarkably neat, and the last mentioned, attracted particular attention from its finish. The committee have ascertained that these engines were commenced in England, and finished in this country, by the maker, who is now settled in this city; they have received no account of the prices fixed upon them, though they understand them to be specimen articles. They would recommend the maker for an honorary notice.

Three air-pumps, made by Alva Mason, Philadelphia, mechanical powers, electrical machine, pyrometer, Hare's eudiometer, models of pumps, tube for electricity in vacuo, mercurial shower, mouth blowpipe, stop-cocks, &c., Hare's hydrogen apparatus, various articles of electrical apparatus.

The largest of the air-pumps (price ninety dollars,) deserves particular attention for the neatness of its workmanship; the articles generally support the character which Mr. Mason has attained in his branch of business. The pyrometer is of the form intended for illustration, showing expansion by heat, and the subsequent contraction on cooling. Hare's eudiometer has been modified, the committee suppose with a view to reduction in the price; they conceive that dispensing with the spring valve, will not facilitate manipulation with it. The models of pumps are very neat. The form given to the glass for the mercurial shower, is particularly appropriate. The committee recommend that honorary mention be made of Alva Mason for the articles of philosophical apparatus deposited by him.

Two time keepers, of excellent workmanship, by Mr. Fatton, one with a horizontal, the other with a vertical balance.

Models of crystalline forms, by John Cooper.

Compound microscope, by John Boggs.

A double barrel air pump, of large size, by Samuel Coltman; this instrument competes very successfully with that already referred to as made by Alva Mason, and some of the parts have, in fact, a higher finish: the difficulty of obtaining brass castings entirely free from flaws, was apparent in both the pumps.

Self-acting blow-pipe, alcohol blow-pipe, by J. Millington; very neat in form, of good workmanship, and well worthy of the attention of those who use this variety of the blow-pipe.

Improved turned compass sights, by B. Stancliff.

Clock, by Bladenburgh & Jones.

Model of a low pressure engine, by Joseph Moore.

Hemispheres, (Magdeburg,) by Joseph Wyepp.

Tellurian, by W. R. Thomas, of Lancaster, Pennsylvania. This instrument, which is intended to exhibit the motions of the earth and of her satellite, is well put together, and the parts which belong to the depositors are so combined with others as to represent effectively the intended motions: the instrument might be made usefully to subserve the purposes of the instructor in astronomy.

Improved compass and goniometer, by Wm. J. Young. The compass has a telescope attached, and as well as the goniometer, is intended for the purposes of the civil engineer; in particular operations they would no doubt prove useful. The workmanship is in good style.

Trammel, for drawing eclipses, by J. Millington, a very neat and effective instrument.

Compass by J. Millington.

Achromatic pocket telescope, spectacles, achromatic object glass, various lenses of different focal lengths, by J. Schnaitman. The lenses attracted special attention by their finish; the object glass was small, but the lenses constituting it beautifully ground; the committee had no means of testing its achromatism, as it was not mounted: they hope that Mr. Schnaitman will persevere in a branch in which he seems so successful.

A. D. Bache,
Joseph Roberts.

Report of the Committee of Judges on Lamps.

The committee of judges of lamps for the annual exhibition of the Franklin Institute, beg leave to report—

That they have been highly gratified with the richness of colour, beauty of form, and exquisite finish of the lamps, both astral and mantel. The mantel lamps of C. Cornelius & Son, were particularly admired; the brass castings are graceful and durable, and exhibit a great richness of hue. The bronzing is decidedly superior to that of former specimens, and while it is of a fine tint, is said to stand the action of air, of weak acids, and alkaline solutions, proving its resemblance in these important particulars to the best English productions of the same kind. The cast pillar icicles, by which they are decorated, are of English make, but the cut glass dishes, tops, and lamp glasses are American, of perfect transparency, and tasteful cutting. We were much pleased with a very simple contrivance to lessen the quantity of leakage into the escape cup, by which the trouble and soil of the cleaning operations are much lessened. The astral

lamps of the same artists are remarkable for new, original, and delicate forms, excellent bronzing, and moderate price, affording in every particular, evidence of steadily progressive improvement.

The committee were not less pleased with the lamps of anthracite coal from the factory of J. W. & E. Kirk. In the selection of coal, the choice of forms, and the beauty of polish, we discover great improvement, and much to praise. The quantity of this article sold by the makers, indicates the public suffrage in its favour, and a confidence in its durability, which we were not prepared to expect. Time and use improve its lustre, oil does not injure it, and it is only by the same accidents to which glass is liable, that its safety is put in jeopardy.

The committee of judges call the attention of the committee on premiums particularly to the beautiful glass mantel lamps from the New England Glass company, deposited by Mr. Muzzey. The cast pillar icicles, and other pendulous ornaments of these splendid lamps, are the first of the kind presented to the public from American sources, and they bear a strict scrutiny for transparency, lustre, and workmanship. The Company have, with much labour, and at great expense, overcome the various difficulties presented in their production, and expect their reward in the public patronage.

The gig lamps by T. Crease, from Horn & Kneass, are creditable specimens of workmanship. The structure is simple. We think, however, that the cut glass windows are injurious to the proper direction of the light, and believe the reflectors might be improved by being plainer. The plating struck us as very good.

Among the lamps we observed the liquid gas lamps of Isaiah Jennings, who has the merit of having succeeded in effecting a combination between the vapour of spirits of turpentine and alcohol, in such proportions as to obviate the offensive smell of the former. The lamps require very little attention, either in use or preparation, and afford a pleasant light at a cost rather less than that from the best sperm oil. The hazard of handling the combustible liquid is the only apparent objection to its use, and as the lamps, when trimmed, are perfectly safe, the preparation of them for daily use should be confided only to discreet hands.

The only other article to be noticed is the creditable attempt of J. M. & G. Truman, to make an improvement in the street lamp for burning oil. The principle is, the elevation of as much as possible of the flame above the wick, so as to prevent its absorption of the light. This is effected by bringing a circular aperture in a metal plate immediately over the burning wick, and by the aid of a long chimney making a strong draft, by which the gas generated by the heated wick is rapidly driven up and burned above the circular aperture. The idea seems good, but the means of reducing it to practical use are not yet adequate to the production of a cheap and manageable effect. The committee hope the Messrs. Truman will continue their praiseworthy exertions.

S. C. Atkinson, Woodbury, N. J., submitted a draught of a lamp for burning imperfect oil in cold weather. It is simple and ingenious,

but, in its present form, liable to several objections, applicable to every lamp in which the reservoir is placed above the flame, and subjected to heat. If the reservoir be air-tight, the heat forces out the oil; if not, gravitation does it. The Saturn lamps are made on this principle, and they have often been reproduced, but as often abandoned.

J. K. MITCHELL.

REPORT OF THE COMMITTEE ON WEIGHTS AND MEASURES.

*Appendix to the Report of the Committee of the Franklin Institute on Weights and Measures.**

In compliance with the appointment of the Board of Managers, a meeting of the committee was held at the Hall of the Institute, June 20, 1833.

When T. McEuen, M. D. was requested to examine the papers and reports made on weights and measures in France, and condense the same, in a report for the use of the committee.

Mr. Sears C. Walker, to perform the same duty with regard to papers and reports made in England, and

Professor Alex. D. Bache to report on the proceedings on the same subject in the United States.

At subsequent meetings of the committee, held at the Hall of the Institute, August 1st and 3d, 1833—the gentlemen before referred to, presented their reports, which were read, and ordered to be printed, for the use of the committee—

On motion, Dr. Moore was requested to furnish the committee with the authentication of the Troy pound used in the mint of the United States—which document was also ordered to be printed.

Report on the Weights and Measures of Great Britain. By S. C. WALKER.

The subscriber having been instructed to inquire concerning the means used in Great Britain for procuring an invariable standard of weights and measures, respectfully submits the following report.

All standards of length, weight, and capacity, may be arranged under three general divisions.

I. Variable natural standards.

II. Artificial standards.

III. Invariable natural standards.

I. The barley corn, the foot, the ell, the span, the cubit, and the hand, are all variable natural standards of length. The dry grain of barley corn, taken from the middle of the ear, is a variable natural standard of weight. The vessel that contains a definite number of

* We have deemed it adviseable to present to our readers these documents, which are necessary to a full comprehension of the report to which they are appended. COM. PUB.

these grains of barley corn, is a variable standard of capacity. These vary in different countries, in different years, in different fields, and in different parts of the same field, and can never lead to certain or accurate results.

Weights and measures previous to A. D. 1492.

Yet, defective as these standards are, they alone can enable us to estimate the value of legal measurements and weights made in Great Britain previous to the date of the discovery of this country by Columbus.

It appears from some ancient chronicles, that uniform weights and measures were established by law before the conquest by Canute. The value of these weights and measures is not known. The laws which regulated them were not well enforced. Henry I. ordained that his arm should be the standard for long measures. Richard I. caused standard measures of length to be made of iron, those of capacity with iron brims, and directed that these, as well as standard weights, should be kept by the sheriffs and magistrates of the towns. The value of these measures is unknown.

Magna Charta, A. D. 1215, ordains that there shall be one uniform standard of weights, and measures, and of capacity—and that this standard shall be the London quarter. This London quarter continued to be the standard till Henry VII. A. D. 1491. Various acts were passed in this period of 276 years, by successive parliaments, respecting the distribution of the standards among the sheriffs of the different shires and towns; for an abstract of which see Kelly's Metrology, pp. 67 et sub.

The magnitude of the London quarter is not precisely known: we can recompose it from the variable natural standard on which it was based, viz. "the dry grains of barley corn taken from the middle of the ear." Of these 32 make an English penny, called a sterling round without clipping: 20 pence make an ounce; 12 ounces a pound; 8 pounds make a gallon of wine; 8 gallons of wine make a London bushel; 8 bushels make a London quarter. (See 51 Henry III. Stat. 1. cap. 3. 31 Edw. I. 12 Henry VII. cap. 5.)

It is obvious, that every attempt to construct the London quarter from this variable element, the barley corn, must be unsatisfactory. No copy of the London quarter has been preserved, nor is its precise relation to any artificial standard now preserved, known with certainty.

The Winchester bushel deposited in the king's exchequer by order of Henry VII., A. D 1491, is the oldest measure of capacity now preserved. This was ordered to be made in conformity to the ancient standards of the realm, then in the king's exchequer. Our uncertainty concerning the size of the London quarter, of which this bushel ought to be the eighth part, will always be equal to our uncertainty whether the order was faithfully executed, and whether the bushel then in the exchequer was a fair measure of the bushels in use during the three centuries preceding the time of Henry VII.; a point concerning which no authentic accounts are preserved.

II. Artificial standards may be made of iron, of brass, of silver, platinum, &c. The last substance is, probably, the best and most dur-

able; but all are liable to slow decomposition, and were they not so, would be liable to loss and destruction.

Standards of length, and capacity, and weights preserved.

The standards of measure, of length, and capacity, in use in Great Britain since the 11th year of Henry VII., A. D. 1491, are now preserved in the king's exchequer. The standard weights in use in the 31st. Elizabeth, A. D. 1588, are now in the same exchequer. All the modifications which they have undergone by successive acts of parliament, are recorded, and copies of the modified artificial standards are preserved. These standards have all of late been referred to invariable universal natural standards. They have thus become virtually imperishable. Hence we may conclude that in all future time, the legal measurement of length and capacity made since 1491, and the legal weights made since 1588, may be estimated with any degree of accuracy desired.

Referred to invariable standards.

As no change had been made in the laws for constructing the standard avoirdupois pound for six centuries previous to 1824, it is probable that the legal avoirdupois pound now in use in Great Britain, is a fair representative of the ancient pound of the Magna Charta.

Pound avoirdupois.

The pound avoirdupois meaning "the pound to have," that is, the pound for buying, a lighter pound used, having been contrary to statute, for selling, is the ancient standard pound of the Magna Charta. It is called by various names in the old statutes. In 11th Henry VII. it is erroneously called troy. In 24th Henry VIII. it is haberdepois; in Elizabeth's time it is called averdepoiz. It contained 7680 grains by the assize law, previous to 1758. Yet in 1699 it was found to contain only 7000.25 of the grains then in use. The mass of the pound had not varied. Whether the grains of barley had grown heavier, or the artificial grains had changed, is left wholly to conjecture.

Pound troy.

The pound troy was not made legal till 1758. It contained 240 pennies. The pound avoirdupois contained the same number of pennies. The troy penny contained 24 grains of barley. The sterling penny, from which the pound avoirdupois was constructed, contained 32 grains. At what time the light pennies were introduced into use is not determined. Perhaps the examination of ancient pennies might enable us to decide.

The standard gallon contained eight pounds of wine according to some statutes, and eight pounds of wheat according to others. The gallon of eight pounds of wheat, was of greater capacity than that of eight pounds of wine. These gallons, constructed from variable standards, were liable to variation. To remedy this, in 1699, 12th William III., it was enacted that the wine gallon shall contain 231 cubic inches, and the beer gallon 282 cubic inches. Thus a fixed proportion was established between them. In 1699 the Council of the Royal Society found the Winchester bushel of Henry VII. to contain 2145.6 cubic inches, and the bushel of water to weigh 1131 ounces 14 pennyweights troy. They also found that 7000.25 troy grains were equal to a pound avoirdupois. Of these grains 5780 were equal to a pound

troy. This was made the legal proportion between the avoirdupois and troy pounds in 1758.

In 1758, 32nd George II., a committee of parliament instructed the celebrated optician, Mr. Bird, to prepare a standard yard which should be a mean of all the yards in the exchequer; of this several copies were deposited in the exchequer. | Standard pound troy by Harris.

They also instructed Mr. Harris, the King's assay master of the mint, to make a troy pound, of which a copy, with several parts of the pound troy, were deposited in the exchequer. They also directed avoirdupois pounds containing 7000 grains troy, to be placed in the exchequer, with Mr. Bird's balance, by which they were adjusted.

In 1685, some gentlemen at Oxford determined the weight of a cubic foot of spring water, or 1728 cubic inches, to be 1000 ounces avoirdupois. This established a fixed proportion between the measures of weight and capacity. By this rule the standard bushels were constructed till the year 1824, when the assize laws for capacity were changed.

Comparisons of the standards in the exchequer with Sir G. Shuckburgh's scale, by Troughton, the comparisons made by Shuckburgh, in 1796.

Number of trials.		Date of construction, A. D.	Length in parts of Sir George Shuckburgh's scale.	Difference.	Probable error of graduation.
36	Standard of Henry VII.	1492	35.924	—.076	.03
"	" yard of Elizabeth	1588	36.015	+.015	.04
"	" ell " "	"	36.016	+.016	.04
"	Yard bed of Guildhall	1660	36.032	+.032	
"	Ell " "	"	36.014	+.014	
"	Standard of Clockmaker's Co.	1761	35.972	—.028	
"	Tower standard, by Rowley	1720	36.004	+.004	
"	Graham's standard line E.	1742	36.0013	+.0013	
"	" " Exc'r.	"	35.9933	—.0067	
"	Gen. Roy's (Bird's) scale	1745	36.00036	+.00036	.0003
"	Mr. Aubert's " } 1745 to	1750	35.99880	—.00120	.0006
"	Royal Society's }		35.99955	—.00045	.0004
"	Bird's parliamentary standard	1758	36.00023	+.00023	
"	Bird's parliamentary standard, since called the imperial standard,	1760	36.00002	+.00002	
"	Troughton's, since called Sir George Shuckburgh's scale	1796	36.00000	+.00000	.0001

Hence the mean length of the standard yards preserved in the exchequer is 0.003 of an inch, in the first seven inches, shorter than Sir George Shuckburgh's scale, and consequently 0.003 inch shorter than the imperial standard.

Comparison of standards by Kater, 1821.

The following is the report (Philosophical transactions, Lond. 1821, p. 91.) of Capt. Kater of the lengths of some standards, in inches of Col. Lambton's scale, used in making the trigonometrical survey in the East Indies.

	inches.
Sir George Shuckburgh's standard .	36.000642
Bird's, 1760, since styled "imperial," .	36.000659
Roy's . . .	36.001537
Ramsden's bar, used in making the trig. survey of Great Britain, . . .	36.003147
Col. Lambton's scale, . .	36.000000

In the London Philosophical Transactions, for 1830, Capt. Kater reports the lengths of several standards, in inches of the "imperial standard."

	inches.
Sir George Shuckburgh's scale, . .	3 00018
Russian scale, . . .	35.99932
Dollond's scale, . .	35.99908
Capt. Kater's scale, . .	35.99879
"Imperial standard," . . .	36.00000

Hence it appears that Dollond's scale, which by careful comparisons in 1820 and 1824 appeared to differ little, if at all, from Sir George Shuckburgh's scale, was, in 1830, no less than 0.0011 inches in defect.

Second determination.

	inches.
Shuckburgh's scale, . .	36.00009
Russian do. . . .	35.99929
Dollond's do. . .	35.99893
"Imperial standard," . .	36.00000

Division III.—Invariable natural standards. Earth's circumference.

III. The meridional circumference of the earth, and the duration of the earth's rotation on its axis, are two invariable natural standards: the former of space, the latter of time. These are available at all parts of the earth's surface, and at all periods of time. The measurement of a definite portion of the former, gives one of these standards.

The mode of making this measurement, and the results deduced from it, are given at length in the able report of Dr. M'Euen.

Earth's rotation.

The duration of the earth's rotation is a natural standard measure of time. An artificial relation

between this measure of time, and the measures of length, may be established by means of the pendulum, which makes one vibration in a definite portion of this duration.

The length of such a pendulum becomes a standard of measures of length. The same law of universal gravitation which preserves the invariability of the shape and length of the earth's meridional circumference, preserves at each point of that circumference a moving force invariable at that point. If we could subject a pendulum to this moving force alone, making complete abstraction of all other resisting or disturbing forces, it is obvious that the same pendulum would, in all ages, perform its vibrations in the same definite portion of the time of the earth's rotation, and in the same amplitude of arc, the effect of temperature only excepted. | Earth's gravitation.

By virtue of the principle of the conservation of areas, an expansion of the pendulum from an increase of heat would cause a diminution of amplitude of arc, and an increase in time of vibration. | Effect of temperature.

If, again, we suppose a pendulum subjected to the single force above mentioned, and assume a standard temperature 62° Fahrenheit, for instance, we shall have an invariable pendulum, vibrating in an invariable arc, in an invariable duration of time. If we divide the period of the earth's rotation on its axis, as now reckoned by astronomers into 8640 equal parts. 1.00273791 of these parts will be a mean solar second as now used by astronomers. The duration of this second is invariable. La Place has demonstrated that it could only vary from one of three causes. 1st. A change in the earth's mean secular motion in right ascension; 2nd, from a removal of a considerable portion of the earth's mass towards, or from, the equator; 3d, from a diminution of the earth's equatorial semidiameter, by loss of heat. | Siderial day. | Mean solar second.

The mean disturbing effect of the first is 0. There are no causes now in operation to produce the second. The third cause has not changed the duration of a day a thousandth part of a second in two thousand years. The mean solar second is subject, however, to an equation of one second in three years. (See Herschel's Astronomy, No. 274.) | Invariable, but subject to a small equation.

The pendulum vibrating in a mean solar second at Mr. Browne's house, London, by virtue of the above mentioned invariable moving force at the above standard temperature, 62° Fahrenheit, was measured by Capt. Kater, in 1818, by instructions from a committee of Parliament. In 1819, it was by him reported to be in length 39.1393 inches in parts of Sir George Shuckburgh's scale, which is identical within the limits of possible comparison with Bird's scale of 1760, which was, in 1824, by an act of parliament, made the "imperial standard yard," and only unit of measures of length in the United Kingdom of Great Britain. | Kater's standard. | Length of seconds, pendulum at London in vacuo—at level of sea—at 62° Fahr. | Shuckburgh's scale. | Bird's scale, 1760.

"Imperial standard." | Metre, or 1–40,000,000th part of earth's circumference. | This "imperial standard" contained 36 inches, of which 39.3708 inches of brass at the temperature of 62° Fahrenheit, are equal in length to the forty millionth part of the earth's meridional circumference, and equal in length to the platinum standard metre of France, at the French standard temperature, namely, that of melting ice (0 centigrade, 32° Fahrenheit.) The expansion of brass being for 1° Fahr. 0.0000099590, Kater's estimate, and that of platina for 1° Fahr. 0.0000047583 Borda's estimate.

Expansion of brass. | Expansion of platinum.

"Imperial standard troy pound." | Harris' standard pound troy was made by the same act the "imperial standard pound troy," containing 5760 grains, of which 252,458 grains were equal in weight to a cubic inch of distilled water, weighed in air, with brass weights, at the temperature of 62° Fahrenheit, the barometer being at thirty inches. Seven thousand of these grains make a pound avoirdupois.

Pound avoirdupois.

"Imperial standard gallon." | The imperial standard gallon contains 10 pounds troy of distilled water, at same temperature, and same atmospheric pressure.

The following standards were deposited in 1826 in Westminster, and at the Royal Exchequer:—

1 Imperial standard yard, with gold points.
1 " " " " steel terminations.
1 Imperial troy pound.
1 Avoirdupois pound.
1 " " in a box with smaller weights.
1 Weight of imperial gallon of water.
1 Imperial gallon measure.
1 Bushel.
1 Quart.
1 Pint
A copy of the imperial gallon, quart, and pint.
1 Bushel.
1 Half bushel.
1 Peck.
1 Gallon.
1 Half gallon.
1 Pint.
1 Half pint.
1 Gill.
1 Half gill.
1 Set of avoirdupois weights, from 56 lbs. to half a drachm.
1 Set of counterpoises for above set of weights.
1 Set of troy weights, from one pound to one grain, with counterpoises for each.

Standards deposited at Guildhall, Edinburgh, and Dublin.

1 Imperial standard yard, with gold points.
1 " " " " steel terminations.

1 imperial troy pound.
1 Avoirdupois pound.
1 Weight of imperial gallon of water.
1 Imperial gallon measure.
1 Bushel.
1 Quart.
1 Pint.
1 Set of avoirdupois weights, from 56 lbs. to half a drachm.

The following considerations may be adduced in favour of the adoption of the imperial standards by the legislature of Pennsylvania.

1st. Those of length and weight appear to be the legal standards of Pennsylvania at this time. They were the standards of England in 1760. They were at that time properly the standards of the colony of Pennsylvania, and unless some act of legislation has since passed on the subject, no other standards are at this time legal in Pennsylvania. | 1st. Now legal.

2nd. The adoption of them will cause the least destruction of legal property in the form of legal weights and scales in Pennsylvania. | 2nd. Least loss.

3d. These standards are the mean of the parliamentary standards in use in England since the first discovery of this country. They ought, therefore, most nearly to represent the mean of the measures of length and the weights used in this country since its first settlement. | 3d. Mean of ancient standard.

4th. Should these standards be destroyed they may be easily recovered by the measurement of a definite portion of the earth's meridional circumference; or by measuring the mean solar seconds pendulum, corrected for terrestrial latitudes by rules to be given hereafter. | 4th. Easily recovered by arc of meridian.

5th. The meridian of London is virtually our prime meridian. Our calculations for astronomy and navigation are based upon it. The longitude of Philadelphia from London is better known than its longitude from Harrisburg, and quite as well as its longitude from Washington. | 5th. By second's pendulum.

The seconds pendulum for a vacuum, and for the level of the sea, and for 62° Fahrenheit, varies with the latitude. The adoption of the "imperial standard" would make the latitude of London in this respect the prime latitude. The different formulæ for expressing the length of the mean solar seconds pendulum in a vacuum, at the level of the sea, and at 62° Fahrenheit, for any latitude, in parts of the "imperial standard yard," are

(1)·····Seconds pend. $= 39.01612 + 0.20208 \times \mathrm{Sin}^2$ Lat.
(2)·····Seconds pend. $= 39.01554 + 0.20347 \times \mathrm{Sin}^2$ Lat.
(3)·····Seconds pend. $= 39.01307 + 0.20644 \times \mathrm{Sin}^2$ Lat.
(4)·····Seconds pend. $= 39.01228 + 0.20805 \times \mathrm{Sin}^2$ Lat.

These four different formulæ are taken from Bowditch's notes to the "Mécanique Celeste," vol. vii. p. 480 [2055 p.] and [2055 x.] The coefficients for the first formula are deduced from 52 observed lengths of the seconds | Reduction for latitude.

pendulum in different latitudes, on the principle that the sum of the squares of the errors is a minimum. The second is from Boscovitch's theorem applied to the same. The third and fourth formulæ are deduced in the same manner from 44 of the most uniform of the same 52 observations. It is difficult to say which is most correct; it is probable that either will give the length of the pendulum to the five hundredth of an inch.

Vacuum. Thermometer. Level of sea. Indefinitely small arcs.

By means of one of these formulæ, and of others appended to this report, for reduction to a vacuum, to the level of the sea, to 62° Fahrenheit, and to indefinitely small arcs, it will be in the power of every scientific man to verify, or recover, if lost, the "imperial standard yard." He can then measure a cubic inch of distilled water, or any multiple thereof, at 62° Fahrenheit, and 30. ins. of the barometer, and verify, or reconstruct, the brass troy grain, so that 252.458 grains, or any multiple thereof, shall be equal in weight to the cubic inch of distilled water, or like multiple thereof. He can then verify, or reconstruct, the "imperial standard pound," and the "imperial standard gallon," as above mentioned.

Reconstruction of troy grains.

Pound and gallon.

Seconds pendulum at New York.

The seconds pendulum in New York, lat 42° 42′ 43″ North, was measured in 1828, by Messrs. Renwick and Sabine, and was by them reported to be in vacuo, at sea level, at 62° Fahrenheit, 39.10120 inches of Sir George Shuckburgh's scale. This length is within 0.00037 inches of the length of the seconds pendulum for same latitude, deduced by calculation from the mean of 44 of the best measurements of the pendulum made in different parts of the earth's surface, assuming the compression at $\frac{1}{300}$. See Bowditch's notes to "Mécanique Celeste," as above.

Confusion from discrepancies in standards.

If a seconds pendulum were measured in Washington, Philadelphia, Harrisburg, and Pittsburg, their lengths might be recorded in parts of the "imperial standard yard." These would furnish additional facilities for the recovery, or verification, of them. It would still be well to use the imperial yard: for if Pennsylvania should adopt a different yard referred to some local measurements of the length of the seconds pendulum, other states might adopt a different standard yard, referred to the seconds pendulum of the latitude of their capital; endless disputes about the measurements and weights would ensue in the United States' courts, and the decision of them would become a subject of astronomical jurisprudence.

Shuckburgh's scale.

7th. The celebrated Mr. Troughton constructed, in 1796, for Sir George Shuckburgh Evelyn, a very accurate scale, liable, in its divisions, to no greater error than 0.0001 in. This scale differs by not more than 0.00002 in. from the "imperial standard;" in other words, it is identical with it. With this scale all the standards in the exchequer, including all those with which trigonometrical surveys have been made in Great Britain, have been frequently and carefully compared. The results of their surveys are thus referred to the "imperial standard." The possession

and use in this country of the same standard would facilitate comparisons of trigonometrical surveys made here, with those made in Great Britain.

8th. Sir George Shuckburgh's scale was compared in 1802, with the French metre, by Professor Pictet, of Geneva. Hence this scale, and consequently the "imperial standard," would enable us to compare with facility measurements made here with the trigonometrical surveys made by the French government, and, through their labours, with continental measurements in general. | Pictet's metre of France.

9th. The difference in the length of two pendulums made by Mr. Whitehurst, and vibrating 42 and 84 times in a mean solar minute, at 113 feet above the level of the sea, at 60° Fah, and 30. ins. barometer, is 59.8938 inches of the "imperial standard." We have thus a third invariable natural standard. This may be called the differential pendulum. The invention of the convertible pendulum, by Kater, and the zeal with which observers have multiplied observations with it, aided in their formulæ for reduction by the first analysts of Europe, have prevented the observations of Whitehurst from receiving the attention that is due to them. Some discrepancies detected in the results of Kater's convertible pendulum, vibrating on knife edges, within the last two or three years, together with the difficulty of fixing the constants, in the formulæ for reduction, for latitude, pressure, temperature, altitude, and length of arcs, may yet direct the attention of observers to the differential pendulum of Whitehurst, which does not admit of so accurate admeasurement, but will probably be found to have fewer variables in its formulæ for reduction. | Whitehurst's pendulum.

Sir G. Shuckburgh also found by a great number of trials, that a cubic inch of a scale 0.0002 in. shorter than the "imperial standard," since adopted, at barom. 29.74 inches, therm. 66°, weighed 252.422 grains, since made parts of the imperial standard. | Cubic inch of distilled water weighed.

He found by repeating Whitehurst's measurements with the *differential* pendulum, the same results as those given above.

The "imperial standard" pound troy made by Harris with a two-pound and another pound weight, made by the same, when compared with Troughton's weights, by Shuckburgh, gave the "imperial standard" pound equal in weight to 5763.78 grains of Troughton.

In the statement of the length of the mean solar seconds pendulum, in any given latitude, at the level of the sea, and at 62° Fahrenheit, the invariability of its length was inferred from the invariability of the moving force.

The search after the length of this pendulum in different latitudes, has occupied much of the time of the most careful observers, and most skilful analysts of Europe, for the last fifteen years.

But though such an invariable force exists in nature, we can never in practice separate it from other forces which modify the observed length of every seconds pendulum.

These forces are,—friction at the point of suspension, resistance of

the medium passed through, terrestrial and electro-magnetism, and, probably, the attraction of mountains, and the variable density of

Convertible pendulum. | geological strata. It has been customary for observers to use a convertible pendulum vibrating on knife edges, whose distance from each is adjusted by tangent and friction screws, in such a manner that the pendulum makes nearly 8640 vibrations in a mean solar day, whether suspended by the one or by the other knife edge.

Coincidences. | As the pendulum has no maintaining power, and does not vibrate continuously through the whole day, its coincidences with the pendulum of some standard mean solar, or siderial clock, carefully regulated by frequent celestial observations, are noted, and recorded, together with all the varying circumstances of

1st. Amplitude of arcs at beginning and end of each coincidence.

2nd. Height of the thermometer.

3d. Height of the barometer.

The amplitude of the arc should not exceed 1° 30′.

The number of coincidences, and amplitude of arcs, should be nearly the same with both knife edges.

The agate planes on which the knife edges rest, should be firm, smooth in the concave surface of the grooves, and well levelled, so that a removal of the knife edges 180° in azimuth, shall cause no change in the number of vibrations between the coincidences.

Measurement of length. | The observer then measures the distance of the knife edges, the absolute and specific gravity of each part of the pendulum, together with the distance of the same from each knife edge; the pressure of the atmosphere, and the temperature of the air, and of each weight, or measure, used in making these estimates. The duty of the observer is then finished, if his estimates are made with sufficient care; the actual length of the seconds pendulum affected by all these disturbing forces, will have been reported by him without an error of more than 0.0001 inch.

Limit of accuracy of measurement. | It appears from Baily's paper on the pendulum, Lond. Philos. Trans., 1832, that the observations of Kater, on which the length of the imperial standard yard now rests, were liable to error from too great amplitude of arcs, and from his omission to measure and report the effect upon the number of vibrations of change of each knife edge through 180° of azimuth.

The height of the place of observation above sea level, and its latitude, must also be measured and reported.

Corrections required. | The requisite observations and measurements having been made, it belongs to the analyst and theorist to assign to each of the disturbing causes, its proper effect upon the reported diurnal number of vibrations, and to correct this number for the same, and thence to deduce the length of the theoretical, or comparable, mean solar seconds pendulum, due to the single force above mentioned, acting at that point of the earth's meridional circumference. In making these corrections, several constants are used, the value of which is variously estimated by different observ-

ers. By using the same formulæ, and the same constants for the corrections, Kater's and Biot's separate and independent observations on the length of the seconds pendulum at Unst and Leithfort agree within the limits above stated, viz. 0.0001 inch.

Agreement of Kater's & Biot's observations.

By using the formulæ and constants employed by different calculators and observers of equal celebrity and authority, we find discrepancies between the estimated and observed lengths of the mean solar seconds pendulum, corrected as above, at the same place, of at least 0.0007 inches.

In the present state of science, we may therefore conclude that the limit of accuracy in the estimated seconds pendulum, even at London and Paris, is 0.0007 inch.

Limit of accuracy at London, Paris, and other places.

In other latitudes, where the seconds pendulum is estimated from the report of a single observer, the limit of accuracy is not less than 0.001 inch. This is the case with the latitude of New York city, where the length of the seconds pendulum rests upon the observations of Messrs. Renwick and Sabine. Where the length of the seconds pendulum has not been measured by actual experiment, the formulæ above given for correction for latitude, will give the length of the seconds pendulum within the limit of accuracy of 0.002 inch.

We may therefore conclude that the length of the seconds pendulum at Washington, Philadelphia, or Harrisburg, may be determined from theory, without observations, within one five hundredth part of an inch.

Limit of accuracy of theory for Philadelphia, Washington, or Harrisburg.

Corrections to be applied to the number of vibrations of an invariable pendulum.

For arc. $$\text{Correction} = +\,\mathrm{N} \times \frac{\sin\,(\mathrm{A}+d) \times \sin\,(\mathrm{A}-a)}{32\,\mathrm{M}\,(\log\sin\mathrm{A} - \log\sin a)}$$

For rate. $$\text{Correction} = +\,\mathrm{N} \times \frac{r}{86400'' + r}$$

For expansion. $$\text{Correction} = +\,\mathrm{N} \times \frac{1}{2} \times e\,(t - \mathrm{A})$$

For height used by Kater in 1818. $$\text{Correction} = +\,\mathrm{N} \times \frac{h}{\mathrm{R}}$$

For height used by Kater in 1819, by suggestion of Dr. Young. $$\text{Correction} = +\,\mathrm{N} \times \frac{h}{\mathrm{R}} \times x$$

For atmosphere, used by Kater in 1818. $$\text{Correction} = +\,\mathrm{N} \times \frac{1}{2\left(\frac{\mathrm{G}}{g} - 1\right)} \times \frac{\mathrm{B}'}{\mathrm{B}} \times \frac{1}{1 + .002083\,(t' - t)} \times \frac{1}{1 \times .0001\,(\mathrm{T}' - t)}$$

For atmosphere, used by Baily in 1832, from investigations of Gauss, Airy, and others.

$$\text{Correction} = +N \times \frac{1}{2\left(\frac{S}{g}-1\right)} \times \frac{B'}{B} \times \frac{1}{1+u(T'-t)} \times \frac{1}{1+d(t'-t)}$$

For atmosphere, used by Baily in 1832, determined by experiment with vacuum apparatus.

$$\text{Correction} = +C' \times \frac{B'}{1+.0023} \times (t'-32°)$$

Explanation of the foregoing notation.

N	= the number of vibrations in 24 mean solar hours as shown by clock.
N′	= N + the corrections for arc, rate, and expansion.
N″	= Number of vibrations in rarified medium, corrected for arc, rate, and expansion.
A	= Semi-arc of vibration at commencement.
a	= Semi-arc of vibration at end.
M = 2.302585093	= Logarithmic modulus.
r	= Rate of the clock: *minus* if losing.
B	= Height of the barom. } assumed as standards
t	= Temp. (Fahr.) of air. } for specific gravity.
A = 62° (Fahr.)	= Temperature (Fahr.) of the air assumed as standard for pendulum.
B′	= Height of the barometer. } Pendulum
t′	= Temp. (Fahr.) of the air. } swung in
T′	= Temp. (Fahr.) of the mercury. } full pressure.
B″	= Height of the Barom. } Pend. swung in high-
t″	= Temp. (Fahr.) of air. } ly rarified medium.
G	= Specific gravity of pend. } Compared with water considered as unity.
g = $\frac{1}{836}$ for B, 29.27 and *t*, 53° Shuckburg; or $\frac{1}{770}$ for B, 29.928 and *t*, 32° Arago and Biot.	= Specific gravity of air. } Compared with water considered as unity.
S	= Vibrating specific gravity of the pendulum.
s′, *s*″, *s*‴	= Specific gravity of each body of pendulum, determined in usual manner.
d′, *d*,″ *d*‴	= distance of each body of pendulum from point of suspension.
w′, *w*″, *w*‴	= Weight in air of each body of the pendulum.
h	= Height of the place above the level of the sea.
R	= Radius of the earth at the latitude of the place.
x from .50 to .75 Young.	= a quantity determined from theory.
u = .0001 inch.	= expansion of mercury for 1° Fahrenheit.

d $\left\{\begin{matrix}\frac{1}{450}=.0023 \text{ of bulk} \\ \text{with moisture.}\end{matrix}\right\}$ Expansion of air for 1° Fahrenheit.

$$S = \frac{w'\,d' + w''\,d'' + w'''\,d''' + \&c.}{\frac{w'\,d'}{s'} + \frac{w''\,d''}{s''} + \frac{w'''\,d'''}{s'''} + \&c.}$$

e = Tabular expansion for 1° Fahr. of metal of pendulum.

$t^0 = \frac{1}{2}(t' - t'')$

$$C' = \frac{N'' - N'}{B' - B''} \times [1 + .0023\,(t^0 - 32°)]$$

The above formulæ in the present state of science, are considered as nearly perfect as possible; by them the length of the comparable seconds pendulum may be deduced from the observed seconds pendulum. The correction for height used by Sabine in 1830, was, at London,

$x = 65.755$ for comp. $\frac{1}{1850}$
$x = 67.344$ " " $\frac{1}{1900}$
$x = 68.828$ " " $\frac{1}{3000}$

The correction for temperature used by Sabine at Paris and London, was — 0.421 vibration for + 1° Fahrenheit. The expansion of platinum has been given above, that of brass, is as follows:—

Expansion of brass for 1° Fah. =	0.0000995456	Dulong and Petit.
" "	0.0000098888	Borda.
" "	0.0000099590	Kater.
brass scale	0.0000103077	Roy.
" cast	0.0000104166	Smeaton.
" bar	0.0000104850	Hassler.
" wire	0.0000107407	Smeaton.
" rod	0.0000105155	Roy.
Apparent cubical expansion of mercury for 1° Fah. =	0.0000857339	Baily.
Absolute	0.0001001001	"
Air dry,	0.0020833333	"
Air moist	0.0022222222	"

The pendulum can never be swung in a perfect vacuum, nor can friction at the point of suspension be completely obviated. The number of vibrations must therefore be corrected for these retarding forces. Moreover, since the temperature is seldom uniform at 62° during the observation, this must also be considered in making these corrections. Again, the momentum of the pendulum round its axis of suspension, and, consequently, its ability to overcome these varying resistances, depend upon the specific gravity of the pendulum.

Vibrating specific gravity.

But the momentum of the pendulum round its axis depends upon the distance of its parts from the axis of suspension, by which, in overcoming resistance, gravity acts at a longer or shorter arm of the lever. This compound effect is called its vibrating specific gravity. The absolute specific gravity of a pendulum may be measured with any degree of precision desired.

It is probable that no two observers would agree concerning the vibrating specific gravity. A small quantity of air is dragged with the pendulum, changing its vibrating specific gravity. This moving, or vibrating, quantity of air is resisted by the air through which it swings. It is extremely difficult to estimate the shape, or vibrating specific gravity, of this pneumatic metallic pendulum. If even this difficulty were obviated, another source of error would remain. The specific gravity of the air is variously estimated by different observers of high authority, Shuckburgh, and Biot and Arago. Kater's convertible pendulum dragged 8.339 grains of air with it; this was not allowed for in his estimate of the length of the seconds pendulum for the "imperial standard," and is therefore a source of error in that estimate. Mr. Baily, in 1830, found that by turning the knife edge A of Kater's convertible pendulum through 180° of azimuth, he caused a variation per day of 3.135 vibrations.

Air dragged with pendulum.

Kater's pendulum.

The same process with B,	0.939	"
Again, on another plane, A,	0.135	"
" " B,	1.928	"

Indicating another source of error in Kater's determination.

Captain Sabine, in 1829, compared the vibrations of Kater's pendulum at Browne's House, London, with those of the same at Greenwich, and found at Greenwich a retardation of 0.3 vibrations, instead of a calculated acceleration of 0.52 vibrations, making a discrepancy of 0.72 vibrations. This, however, only causes a variation of 0.00069 inch in the length of the seconds pendulum.

In 1828, Capt. Sabine determined the acceleration between Paris and London to be 12.05 vibrations. But Kater's London, and Biot's Paris pendulum for seconds differ 0.01065 inch, corresponding to an acceleration 11.5 vib's. Thus the difference 0.55 gives a discrepancy of 0.00023 in the length of the seconds pendulum; applying this to Biot's pendulum, 39.12843 in. — 0.00023 in. = 39.12820 in. which is a mean between Biot's and Borda's determinations, being 0.1 vib. nearer to Biot's than to Borda's.

Comparison of Kater's, Biot's, and Borda's estimates.

Capt. Sabine, in 1830, having constructed a pendulum more nearly symmetrical in shape, and having reduced its length to the conventional standards by the latest formulæ, and constants for reduction, reports the length of the seconds pendulum to be, at Greenwich, 39.13734 inches, differing from Kater's determination by — 0.002.

Discrepancies between Kater and Sabine.

This discrepancy is calculated to cause some doubt concerning the determinations of both.

In a paper in the London Philosophical Transactions, 1832, Baily has shown that the factor $n = \frac{C'}{C}$, (see formula above,) is not the same for the two edges A and B of Kater's, nor for the two edges of Sabine's supposed convertible pendulums. This accounts for a part of the discrepancy; for the remainder—we may account by attributing it

to an oversight in Sabine's observations, in other respects pretty accurate.

Capt. Sabine omitted to make the same number of coincidences with each knife edge; in this the source of error probably consists. In his pendulum, the centre of gravity is 26.23 inches from A, and 13.21 inches from B. Hence $\frac{26.23 \text{ in.}}{13.21} = 1.985 =$ factor by which any alteration in the results from knife edge A must be multiplied, in order to obtain corresponding alterations in those from B, and

$\frac{13.21 \text{ in.}}{26.23 - 3.21} = 1.015 =$ the factor for affecting A from change in B.

Thus for a removal of the slide, using different factors, we deduce for vibrations per day,

86067.72
86068.46
86069.06

Probable cause of error in Sabine's estimate.

If either of these results were deduced from an equal number of trials of each knife edge, it would be adopted as correct: but as Sabine made 188 trials with A, and 54 with B, his results are liable to similar discrepancies, and his variation from Kater's result is probably in part owing to this omission.

S. C. Walker.

AMERICAN PATENTS.

List of American patents which issued in August, 1833.

With Remarks and Exemplifications, by the Editor.

1. For an improved *Protractor*, denominated the "Facilitating Protractor;" Elisha Brown, Tiffin, Seneca county, Ohio, August 1.

The paper upon which plotting is to be done, is fixed upon a square drawing board, or plane table, in the usual manner. The rule by which the lines are to be drawn, is divided so as to form a scale of equal parts; and to adapt it to laying down lines at any required angle, by means of a pin on which it works, it is affixed to a straight piece which is to slide against the sides of the drawing board, like the head of a T square. Upon the outer edge of this piece there is a protractor, divided in the usual way; the pin upon which the rule works being in its centre, and the end of the rule extended out so as to form an index and vernier, which points out the angles.

There is no claim made, but we are informed that "this instrument is intended to supersede the use of all other instruments in plotting, with the exception of a pin, a pencil, or pen, and the dividers in dividing circles."

We have seen many instruments the same as this in principle, and some that offer advantages which this does not present. The fact is, that the utility of something of the kind is so obvious, that no doubt the thoughts of hundreds of different individuals have been directed

to the snbject. We have prevented the obtaining of more than one patent for such an instrument by advising the applicant that the affair was not new. One edition of "Adams' Geometrical and Graphical Essay," is that of 1791, and the second plate in it represents a protracting parallel rule, which affords all, and more than all, the facilities which that above described is said to present.

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2. For a *Rotary Machine;* Elisha Hall, Hyde Park, Dutchess county, New York, August 3.

This, the patentee informs us, is a patent for improvements on the *rotary machine*, for which he obtained a patent on the 20th day of May, 1825. The instrument is, in fact, a rotary pump, or engine, for raising and forcing water; in its construction it resembles many other rotary engines, having two valves which are to revolve in an annular chamber furnished with supply and discharge tubes. Although in principle it is identical with several preceding attempts, there are in it several contrivances, or appendages, which have some novelty in them; but these do not appear to be of a character likely, in any degree, to remove the main objections to such pumps.

After giving the particulars of his arrangement, the patentee claims "the before described combination or arrangement of the several parts of the pump, and requisite fixtures for to be attached to the same." After this, there are thirteen *particular* points claimed, some of which are new, some old, and some trifling. We cannot give them all, but will furnish a sample. In the pump, as formerly patented, there were three rotary valves, and two only are now used; and the "using two rotary valves in the wheel and channel of the pump, in the place of three," forms one of the claims. Now we could point out twenty patented rotary pumps, with two valves only. *Globular valves* are also claimed, which consist of round balls fitting into hollow valve seats, the curvature of which is adapted to them; these are old enough. A label is to be stamped upon the pump with a die in a circular form, and this makes the last of the claims!

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3. For a *Boot Cramper;* Dimon B. Barnum, New Fairfield, Fairfield county, Connecticut, August 5.

The patentee has, most likely, a clear conception of the construction and use of his cramping machine, although he has not succeeded in furnishing a very exact description of it; with the aid of the drawing, however, it may be pretty well understood. The leather to be cramped is placed upon the edge of a half inch board, notched into proper form, and held in a suitable frame; a follower is then brought down, having, upon its lower side, two jaws which embrace the leather and the half inch board: this is to be pressed down upon the leather by means of a lever, four feet long, and having its fulcrum at one end, and about six inches beyond the cramping board. The corners of the leather, below the jaws, are to be caught and extended by a contrivance fixed for that purpose. No claim is made to any part

of the machine, and there is very little difference between it and some others in the patent office.

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4. For a plan for *Marking off and Cutting Garments*, called "Beard's Graduated Patent Rule;" George Beard, jr., Whiteland, Chester county, Pennsylvania, August 5.

A small sized garment is to be marked on the middle of a piece of paper, and a large sized one at its extremities. The intermediate space is to be occupied by the requisite number of intermediate sizes. The pattern is to be perforated with "orifices or incisures," made through at each pattern, so that it can be laid on the cloth, and marked through, for a garment of any size. We are informed also that "the component parts of a garment may be put separately on separate pieces of paper, when most convenient" "The plan of graduating sizes on a pattern, as well as the adaptation of such patterns to marking off, and cutting out, coats, vests, and pantaloons, and all other garments and parts of clothing, is claimed as this invention."

We suppose, that, hereafter, the women must call with their patterns, upon the patentee, and have them stamped, in due form; not for coats, vests, and *pantaloons* only, but for *all other garments*.

The patentee must, we imagine, have made the notable discovery that not only men and women, but men and boys, are all made to one scale, in length, breadth, and thickness; a thing which had never before been dreamed of, and which, if correct, must lead to very important results. We see no reason, if this be the fact, why by sending to the taylor the exact length of the leg, or of any other member, we may not, without further trouble, have a suit of clothes made with mathematical precision.

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5. For a *Washing Machine;* George W. Wilson, Dunstable, Hillsborough county, New Hampshire, August 7.

This washing machine is to produce its effect principally by the action of two hammers, or beaters, made like those of a common fulling mill, which as they play in a trough by a crank motion, squeeze the clothes against a breast work of fluted rollers. The size and arrangement of the respective parts are given with the utmost precision, under twenty different heads. The claim is to "the arrangement and putting together of the various parts as specified, and the application thereof, and of the powers and principles embraced in the construction of the machine and its operation, (in the manner above set forth,) for the purpose of washing clothes, the said powers being the crank and tread powers *regulated by the balance wheel.*"

In this claim we think that there is a little too much amplification, as all that can by any possibility be accounted new in the machine, is the particular arrangement of its respective parts. The application of the crank and tread powers, *regulated by the balance wheel*, appears to be considered as something special, but why it should is difficult to tell, as they are very generally applied to machinery.

6. For a *Machine for Shelling Corn;* Michael Carpenter, city of Lancaster, Pennsylvania, August 8.

This patent is obtained for improvements upon the shelling machine patented by the same person, on the 25th of October, 1832. The general construction of the machine is the same with that formerly described, but in the particular form given to the parts it is undoubtedly improved. The specification also, sets forth more clearly, and claims more distinctly, the things intended to be patented; we cannot, however, follow the patentee through his description, as the aid of the drawing could not be very well dispensed with in any such attempt. So far as we can judge by the evidence before us, the machine appears to be well calculated to answer the purpose intended.

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7. For a *Straw Cutter;* Benjamin R. Green, Warwick, Kent county, Rhode Island, August 8.

The claim made by the patentee will afford a tolerably correct idea of the mode in which this straw cutter acts; it is in the following words:—

"What I claim as new, and as my own invention in the above described machine, and for the use of which I ask an exclusive privilege, is the construction of a machine for cutting or chopping straw, or hay, for cattle and horses, having knives, inserted in, or fastened to, the circumference of a cylinder revolving on its own axis; the cutting edges of said knives coming in contact with the circumference of another cylinder, of lead, or other soft metal, revolving on its own axis, cuts or severs the substance passing between them; the surfaces of these cylinders being held in contact by slide boxes and screws, and drawn together by the same means, when worn away by use."

The cutting cylinder, with its knives, is placed above a cylinder covered with lead, and the straw is fed between them by means of a trough. The cutting cylinder has rims projecting out at each end to receive the knives which extend from one to the other. The number of knives must be governed by the size of the machine, as must also the velocity of the motion. The cylinder covered with lead may be moved with the same, or with greater or less velocity, than that of the cutting cylinder, the main object of its motion being constantly to vary the part upon which the knives shall act.

The specification is clearly drawn up, and we think conforms in all respects with the requirements of the law.

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8. For an improvement in the *Manufacture of Axes and other edge tools;* Joseph P. Hazard, South Kingston, Washington county, Rhode Island, August 9.

We have been requested by the patentee to postpone our notice of this patent for a short period; we shall, however, hereafter, publish the specification, or make such observations respecting it as may appear proper. We generally delay our notices for about six months, excepting in those cases where inventors desire an earlier insertion of their inventions, wherever a good reason is furnished for further

delay, as in the present instance, we unhesitatingly comply with the request, but not otherwise, our duties as public journalists will not admit of more than this. A patent is granted by the public, and they have a right to know for what, or no judgment can be formed of the validity of the claims of those who declare that they have invented something which is both "new and useful."

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9. For a *Rail-way for Raising Vessels for repair;* Thomas R. Gedney, city of Washington, District of Columbia, August 9.

We are entirely at a loss to tell for what this patent is taken; the patentee, however, in his claim, says that "the improvement or invention consists in simplifying the operations now resorted to, either at a very great expense, or with complicated machinery, in order to the attainment of the object heretofore referred to; a simple set of rails being introduced, and made to answer the purpose instead of a double set of ways," &c. &c.

The first efficient marine rail-way, was that patented by Moreton, in Scotland, one of which is erected and is in use in Philadelphia; and there are several others in the United States, of a very similar construction, but having certain improvements in them for which patents have been obtained; they are not, it is true, quite so simple as that represented in the drawing accompanying this specification, although they do not differ from it excepting in having those appendages without which the machine sketched by the patentee, would be of no utility. It may be most confidently asserted, that should any one attempt to build a marine rail-way by the information afforded by this specification, and the drawings which accompany it, he would fail most completely; the defect of the specification not being the absence of novelty merely, but a total want of completeness in matters of detail.

The drawing is essentially defective, being without the written references required by law.

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10. For an *Animal Trap;* Henry Adams, Erie county, Pennsylvania, August 10.

This trap resembles some of those for catching rats, having a fall which descends, when the animal enters it for the purpose of taking the food placed on a platform at its centre. There are, it appears, some points of arrangement in which it differs from those commonly made, but they are not pointed out, nor is any thing claimed.

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11. For an improvement in the *Mode of Manufacturing Tobacco;* for which two patents have been previously issued to the applicants; the first dated April 3, 1827, and the other December 6, 1831, which two patents have been surrendered, and a new one issued on an amended specification. John Allen, jr., and Charles Geoghegan, Richmond, Virginia, August 10.

By the two last of these patents it would appear that the patentees are aliens, who have resided upwards of two years in the United

States; the first specification, however, was issued to them as citizens; this, no doubt, occurred by an oversight, somewhere, and probably may be considered as corrected by the surrender of this specification. The patent obtained in December, 1831, was for precisely the same thing as the first, but the specification entered more extensively into particulars than the former, without, however, stating, with sufficient distinctness, what were the points claimed. Both these patents have now been surrendered, and one issued in their place for the unexpired part of the fourteen years, dating from the first patent. This was the only correct mode of procedure, as the second patent was invalid from its very nature, a similar one having been previously obtained by the same persons.

The specification upon which the present patent is taken is in nearly the same words with that of December, 1831, which, however, had no claim; whilst this ends with the following claim:—

"Now what we particularly claim as our invention, and which we wish to secure by letters patent, is the before described mode of cutting the tobacco, after being rolled, spun, wound, or laid, on boards, and flattened; and though we specify fully the manner in which the entire operation is performed, we wish it to be distinctly understood, that we make no claim to the mode of rolling, spinning, laying, or flattening the tobacco."

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12. For *Manufacturing Paper, for the Walls of Houses;* James P. Howland and Alfred Griswold, Muncey, Lycoming county, Pennsylvania, August 10.

Although it is no uncommon thing to take patents for what has been known and practised for many years, and sometimes for ages, we are still surprised whenever it occurs, especially in those cases where the thing patented has been one of much notoriety, as in the instance before us.

Fifty years ago, what was called flocked paper, for papering rooms, had become an old invention; it, however, has never gone entirely out of fashion, for when well made, as in many of the beautiful patterns imported from France, the effect produced by it is unique. It is for this application of woollen flocks to paper that the patent is obtained, by which these remarks are elicited, as will be seen by the following claim.

"The undersigned claim as their peculiar joint invention, the use of the shearings, or flocks of cloth, taken from the same in the manufacture thereof, for the purpose of covering the surfaces of paper, muslin, linen, leather, and wood, for useful and ornamental purposes. They claim further the invention of applying the same by a sieve, in any manner that the same may be used, and of preparing the paper, or other matter to be covered, by a strong, adhesive sizing, as above stated, and of fixing the shearings, or flocks, by pressure.

13. For an improvement in *Millstones, for manufacturing grain into flour;* Jacob B. Minick, Manlius, Onondagua county, New York, August 10.

The improvements are stated to consist in a new method of dressing the mill stones; and in a mode of cooling the flour as fast as it is ground, by forcing air between the stones whilst in operation.

We are told that in dressing the stones an additional furrow is to be cut in each land, or from two to twenty on each mill stone; all the furrows are, also, to be cut much deeper than usual, especially towards the eye of the stone, where they may be from three-quarters to an inch and a half deep; they are to extend about two-thirds of the way from the eye to the periphery, and are to cross the ordinary furrows.

The cooling is to be effected by means of a cylinder fixed to the eye of the stone, its length being about equal to the thickness of the stone, and is to revolve with it; on its inside, vanes are to be fixed, bending spirally, so as to force the wind down between the stones, and along the furrows.

There is a drawing intended to exhibit the manner of dressing the stones; but of the cylinder, with its vanes, there are no drawings, leaving the patent materially defective in this particular; for an illustration of this part, the model being referred to.

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14. For a mode of *Curing Asiatic or Spasmodic Cholera;* Anthony Hunn, senr., M. D., Lancaster, Garrard county, Kentucky, August 12.

As soon as the symptoms appear, blisters are to be applied to the pit of the stomach, the crown of the head, on the arms above the wrists, and on the outside of each ankle.

Thirty drops of the following tincture are to be administered every hour.

Paragoric elixir and sulphuric ether are to be mixed in equal parts, and to every thirty drops or half drachm of this mixture, two drops of cajeput oil, and two of oil of anniseed are to be added.

After every discharge inject gr. ij, opii, in half a tea-cupful of warm water.

We presume that preparatory to using the recipe it will be proper to send to Kentucky for a right.

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15. For a *Machine for Setting Saws;* William Hinds, Otsego, Otsego county, New York, August 12.

We shall not undertake to describe the particular form given to this saw set, as it could not be well done without a drawing. The patentee says that he invented it in all its parts, but that he has been since informed that a patent for one very similar to it was obtained in the year 1812, by John Summers, of Pennsylvania; in which case he means only to claim his as an improvement. This does not appear to fulfil the demands of the law, that the inventor should tell in what

his improvement consists; a point which he ought definitely to have ascertained before claiming a patent.

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16. For a *Frieze Window;* William Woolley, city of New York, August 13.

The patentee states that he some years since invented the frieze window, as a substitute for the dormar window, and that it has gone into extensive use in many of the best houses in New York. It receives its name from being inserted in the frieze, under the cornice, and the present patent is taken for an improvement in the mode of fitting up, or finishing, such windows.

For a house of ordinary size, the opening in the frieze may be three feet six inches in length, by twenty-two inches in height. This is to be covered with an ornamental fret work, which may be made of cast iron; and this, when painted white, will appear like an ornament to the frieze, whilst it will admit sufficient light through the frets, and conceal the sash behind it.

"The above described blind, cast from iron or other material, and so constructed as to admit sufficient light and air, while it hides or shades the window, and forms an elegant ornament in the frieze of the cornice, I claim as my invention and improvement."

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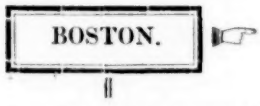
17. For a *Traveller's Night and Day Director;* Robert Charles Manners, city of Boston, Massachusetts, August 13.

A frame is to be made of any suitable material, cast iron being preferred, which frame is to contain the name, or direction, to any particular place in solid letters with an open ground. The letters may be cast in one piece with the frame, or attached to it in any convenient way; it is then to be fixed upon a finger or direction post, in the usual way. Its appearance will be that of the mark in the margin, supposing the white parts to be removed. A word of this description may, it is said, be read with facility on either side, will be visible in the night, excepting in cases of unusual darkness, and may even then, if necessary, be read with the fingers.



It is proposed to form the names of streets, &c., in the same way, in which case lamp posts may serve not only for their ordinary purpose, but to sustain the name in such a situation as shall admit of its being illuminated.

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18. For a process for *Purifying Cotton Seed Oil;* John J. Gerard, city of New York, August 14.

Sixteen pounds of quick lime are to be slacked by pouring upon it eight gallons of boiling water. Twelve pounds of common potash (sub carbonate,) are then to be gradually mixed with the lime and water. The liquid is to be kept in vessels closely stopped, and when wanted for use, half a gill of the solution is to be added to each gallon of oil, and the mixture churned for five or ten minutes. After

this it is to be put into vats, in which the heat of steam can be applied to it, which will precipitate the glutinous matter to the bottom. The oil so clarified is to be used for burning, painting, dressing woollens, &c.

We could cite many instances of the employment of caustic potash for the purification of oil, and among them two previous patents from New York. We have turned to the date of one of these, which is June 13th, 1831, and a notice of it, will be found at p. 333, vol. viii. sperm and whale oils are those named by the patentee, John L. Embree; and it may be imagined that cotton seed oil, if purified in the same way, will furnish a foundation upon which to sustain a new patent; we, however, apprehend that such is not the fact.

We have essayed well purified cotton seed oil for burning in lamps, but have not found it to afford the brilliant light of sperm, nor do we believe that any of the vegetable oils are comparable to it in this respect, although they are applicable to many other useful purposes, and to some of them better suited than any of the animal oils.

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19. For a chisel, called the *Cutting and Cleaning Chisel;* George Page, Keene, Cheshire county, New Hampshire, August 14.

This chisel is intended, principally, to be used with mortising machines, but may be employed for trimming mortises made by hand. It is not very clearly described, although we believe that we understand its construction. A drawing accompanies the specification, but it is without "written references."

The main cutting part of the chisel is to be in the ordinary form, but it is to have a second cutting edge, or chisel, in front, and about three sixteenths of an inch in advance of it. These two parts are to be joined together by two sides, with cutting edges, so that the four sides form it into a quadrangular socket or box. The main cutting side, and the two side pieces are bevelled inwards, the other outwards. In hard stuff, a hole is to be bored, the diameter of which is equal to the width of the main chisel. In mortising, a chip of about one-eighth of an inch is to be cut, advancing towards each end of the mortise, which chips will be forced up, one before the other, through the socket.

Chisels with three sides have, we believe, been used in mortising machines, and the claim in the present case is to "the addition of a fourth edge; or in other words, that side of the box before described, which is opposite to the main part of the chisel, and serves as a support to the side edges."

The main objection to a chisel of this description is the extreme difficulty of keeping it in order, a difficulty which the practical workman will readily perceive; but for this it would undoubtedly operate well. It should have been observed, that the cutting edge of the added side, is above that of the main cutting chisel, and that the side cutters, of course, slope up to it, the whole face forming an inclined plane.

20. For a *Coffee Mill;* Ammi Clark, Berlin, Hartford county, Connecticut, August 14.

This patent is for an improvement on the double mill for which a patent was obtained by Mr. Clark, at a former period. The double mill has flutes, or teeth, on both sides of the runner, and the improvement now patented consists in the manner in which what is called the circular flute, and the guard rim, are formed: the claim is in the following words—

"I claim herein as my invention or improvement, the following things merely; to wit, the carrying of the circular flute and the guard rim, through, or across, the hopper; and the application to mills for grinding coffee, and other substances, of the flanch on the runner, separated into segments at convenient distances from each other."

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21. For a *Stove for burning Anthracite,* denominated the "Combination Stove;" James Atwater, New Haven, New Haven county, Connecticut, August 23.

The objects which the patentee proposes to accomplish by means of this stove, he states to be, 1st, to be able to regulate the draft, and to direct it upwards, downwards, or horizontally. 2nd. The ability of employing a small quantity of coal, and to continue its combustion longer than usual. 3d. To economise heat by turning the draft through pipes, after the combustion has advanced, so as to diffuse it through the apartment. 4th, to clear the stove of ashes, without allowing it to escape into the room.

This stove is too complex to allow of our attempting to give a clear idea of its various parts, to represent which, and the different modes of constructing it, the specification is accompanied by nine figures.

The claims made are to the combination and arrangement of the several parts so adapted to each other as to accomplish the four purposes above proposed. The separate parts so combined, are said to be, 1st, a stove or furnace, either cylindrical or prismatic, having one or more openings in its back, furnished with valves, to open or close as required. 2nd, a chamber in the rear for air and dust, into which the flues open, and having outlets for heated air and smoke, and furnished also with doors below the grate, for the purpose of removing dust, ventilating the room, and regulating the draft. 3d, pipes connected with the air chamber, and intended to diffuse heat through the room. 4th, one or more valves, slides, or stoppers, to regulate the draft through the pipes. This enumeration is closed by a statement that the patentee does "not claim any of the separate parts separately taken, or any particular portions of the separate parts, but the combination and arrangement of all the parts, whether new or old, to form a whole compound instrument, as aforesaid."

A claim of this description seems to require that the parts so combined should present an instrument distinctly characterized by their combination, and we have no doubt that such is the case with the stove before us in the estimation of the patentee; we, however, might be at a loss to tell in what particulars his rights would be violated, were

any one to construct a stove varying in form from those given in the drawings; we presume, however, that the patentee will meet with numerous instances in which he will think that they are invaded.

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22. For an improvement in *Stoves, Grates, or Furnaces;* James Atwater, New Haven, New Haven county, Connecticut, August 23.

We are told that this improvement consists in adding a chamber to a stove grate, or furnace, which chamber is to have outlets at, or near, the top, and also near the bottom, for smoke, air, and dust. This chamber is to be made capable of being divided into an upper and lower section, in such a way that the smoke, &c. may be conveyed through one or more openings in the back of the stove, &c., and be conducted off, either upwards through the ordinary smoke pipe, or down through the chamber and the lower openings. Valves are to be used to regulate the openings through the back. There is to be a wide slider, or stopper, for the purpose of dividing the chamber into two parts, which must be closely fitted and slide on proper ledges.

The claim is to "the addition to a stove, grate, or furnace, of a chamber for heated air, smoke and dust, divided into an upper and a lower section by a movable slide, valve, or stopper; which chamber has an outlet at or near the top, and one or more outlets at or near the bottom, all fitted to receive pipe; and which chamber has also one or more openings below the fire, and as near as may be to the bottom of the chamber, which latter openings are regulated by means of doors, slides, or stoppers, so as to be opened or shut at pleasure.

"I claim no part of the whole instrument described or exhibited in the drawings, as my invention, except the chamber with its appendages as above described."

Although sufficient pains appear to have been taken both with this and the preceding description, to make the things claimed clear and intelligible, we confess that in these, as well as in Mr. Atwater's former patents for improvements in stoves, we have not been able distinctly to perceive the nature and object of his arrangements, and are not, therefore in a condition either to applaud them or to point out what in them we might deem defects.

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23. For an improvement in the *Plough;* Charles B. Taylor, Bainbridge, Ross county, Ohio, August 23.

After giving lengths, breadths, and thicknesses for the mouldboard and landside, and telling how a cast steel share and coulter are to be bolted on to the aforesaid cast iron mouldboard, the patentee claims as his invention "the cast iron share, or first share, cast solid, or in one piece; the steel plate on the landside, the second share being of steel, and split, and made so as to fit on a shoulder on the mouldboard, and over the second share on top, and project an inch and a half on the underside, being welded fast to the coulter at the point, fastened by two screw-bolts to the mouldboard; the coulter of steel or iron split, and extending three inches on the mouldboard, two and

a half on the landside, fastened by two screw bolts, the mouldboard being of the form of the Cary or bull plough."

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24. For *Elastic Seat Saddles;* Bushrod Smith, Romney, New Hampshire county, Virginia, August 24.

The elasticity of this saddle is to be derived from a steel spring which is to be wound spirally round a staple formed of bar iron, the two sides of which are far enough apart for the spring, by its coils, to form a seat.

A spring of this description, long enough to coil round the iron bar, and form a seat, must, we should suppose, when uncoiled extend fifteen or sixteen feet, and it is no simple task to make "a well tempered spring" of this description; besides which they are very liable to break, even when made by the best workmen; we should suppose that a stout elastic webbing wound round in the way proposed for the steel spring, would not be less costly, merely; but more pleasant, less apt to break, and more readily repaired.

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25. For a *Plough;* Elisha Kelly, Bainbridge, Ross county, Ohio, August 26.

The handles of this plough are to be of wood, and certain other portions of it are to be of iron; particular dimensions for the various parts are furnished by the patentee, as also the necessary directions for attaching the mouldboard to the beam and handles. The claim made is to a rod of iron by which the handle is attached to the mouldboard; and a piece of sheet iron which extends "from the top of the landside under the wing, and attached to the handle by means of a screw."

Let the makers and users of ploughs look well to the iron rods, and the pins of sheet iron about them, to see that they are not placed as, and where, the claimant places them, in those of his construction.

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26. For a *Machine for Planeing, Tongueing and Grooving Boards;* James Mac Gregor, jr., Wilton, Saratoga county, New York, August 28.

The planeing part of this machine operates in the same way with the well known English planeing machine invented many years since by Mr. Brama. That is, a wheel fixed to a vertical shaft is made to revolve horizontally, the lower side of this wheel forming the face of the plane. The latter part, the patentee says, is to be made of cast iron, and turned true. In it there are to be sixteen slots, which are to receive the plane irons, and to form the throats of the planes; the irons are to be fixed in their places by means of screws. The edges of the plane irons are to be turned up so as to cause them to operate, in that part, like a turning gouge, whilst the middle part is straight. The board to be planed must, of course, pass on one side of the vertical shaft, and is *traversed* by the planes. The ends of the shaft work in boxes which can be raised and lowered to adapt the planes to the thickness of the stuff to be planed.

The board is to be carried forward by an endless chain furnished with hooks for that purpose, whilst it rests on ways extending in both directions from the planeing wheel.

The jointing is performed by two circular saws, one of which is on an adjustable frame, to adapt it to the desired width of the stuff. This jointing is the first operation effected by the machine, and to this succeeds the tongueing and grooving, which, also, is done by circular saws. For tongueing there are two circular saws on a horizontal shaft, standing at such distance apart as is required for the thickness of the tongue, and two other saws, which are placed with their shafts at right angles to these, one of them to cut above and the other below the board, into the kerfs formed on the edge, and thus to complete the tongue. The grooving is performed by three circular saws, two of which cut the width of the groove, being fixed on the same shaft, like the first two for tongueing; the third, which is on a separate shaft, must be thick enough to take out the middle piece left by the other two. From the grooving saws the board passes under the planes, where it is finished.

We cannot follow the description through all its details, and must omit some which are referred to in the claims. The mode of planeing by a horizontal wheel, and some other things which have been previously done in a similar way, such, for example, as keeping the board down by rollers and weights, are not claimed; those which are so, being "the planeing of timber of any size or dimensions by the principle of the turning tool and plane iron united, as described; or the turning tool separate from the plane iron, or so near as to retain the same principle. The application of the sliding box for the step of the revolving plane shaft to turn in, and by which the revolving plane is raised and lowered to give the desired thickness to the plank. The making the shaft through beyond the face of the revolving circular plane, so as to have a step for the plane to rest on.—The application of the gauge under the plane to keep the shaft down while the plane is operating.—The application of the common circular saws to joint, tongue and groove plank, in the manner before described.—The mode of forming a tongue on a board, by cutting in the edge of the plank horizontally, on each side of the tongue, and then vertically, to form the shoulders by circular saws.—The mode of forming the groove by making two horizontal cuts in the edge of the plank with two circular saws, and cleaning out the timber between these cuts by a circular saw."

The jointing by circular saws has been frequently done, and we do not perceive any essential difference in the mode proposed from that which has been previously adopted. In Woodworth's planeing machine, the grooving is effected by a single circular cutter, operating very much like the third circular saw in the present case; to us the principle appears to be the same, and the three saws no improvement.

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27. For a *Saw for Sawing Staves and other Cylindrical Work;* Sumner King, Chittenango, Madison county, New York, August 29.

The saw in this case is to be a complete hoop, with teeth upon one of its edges. Its diameter must, of course, depend upon the curvature required in the stuff to be cut. The inside of the saw rests against friction rollers, placed in a circle, at equal distances apart, excepting at the point where the cutting is to be effected, a space being left there, equal in width to that of the stuff to be cut. A band is to be placed around the saw, and over a drum by which it is to be turned, and this band is made to embrace the saw around a large portion of its circumference by means of two friction pulleys, which, however, leave it free at the cutting part.

Two of the friction rollers are to have a cant, to incline the saw to keep back on its bearing, which is against friction rollers. The claim is to a sawing machine so constructed.

We believe the plan to be new, but are apprehensive that the stiffness in the cutting part will not be sufficient to cause the saw to work well, without making it inconveniently thick.

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28. For an improvement on *Two wheeled Carriages;* Hazard Knowles, Colchester, New London county, Connecticut, August 29.

(See Specification.)

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29. For a *Truss for Hernia;* denominated the Elastic Concave Padded Truss, without stuffing, Horatio G. Jamison, Baltimore, Maryland, August 29.

The claim to improvement in this truss, is rested mainly on the employment of a concave formed pad, without the introduction into it of any articles in the form of stuffing.

The spring, instead of being a steel plate, is to be formed of a single piece of iron, brass, or steel wire, so bent as to assume the usual shape of the steel spring, and the outline of the pad; the wire is double, occupying each edge of the material with which it is to be covered; thus forming the spring strap, which goes round the body. The two wires are to be kept in their places, parallel to each other, by cleets of tin, or other metal. The wire spring is to be well lapped with woollen cloth, and the ring part which gives form to the pad is also to be brought to the proper thickness in the same way; strong tape is then to be plaited upon the woollen, thus producing an elastic concave pad. A covering of cloth, velvet, or leather, is to be drawn over the whole, and the necessary strap for confining it in its place, sewed on.

The holes in the strap are to pass over a common button, attached to the middle of the pad, the eye passing through a piece of calf skin fastened on to the back of the pad for that purpose.

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30. For an improvement in the *Cotton Speeder;* Luman Parmelee, Poughkeepsie, Dutchess county, New York, August 29.

In this speeder, the condensation of the roping is to be effected by condensing pulleys of nine inches in diameter, covered with leather

on their peripheries. In a machine of ten spools, there will be eleven such pulleys, leaving ten spaces for the roping to pass between them. The axles of these pulleys have whirls on them, all turned by the same strap, which is borne up against them by friction rollers placed between each pair of whirls.

The spool guides are set at an angle of forty-five degrees, that the roping upon the spools, as they fill, may remain at the same distance from the guide, or hook, between the spools and condenser.

The claim is to "the twisting pulley, there being one to every thread, and an additional one to each frame of spools:—the guide which takes the thread or roping from the twisting pulley to the spool:—and the application of the pinion on the axles to drive the spool carriage."

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31. For an improvement in the *Temple for Weavers;* Cyrus T. K. Rollins, Lowell, Middlesex county, Massachusetts, August 30.

We cannot, without a drawing, give a good description of the construction of this temple; the claim made to it is, "the giving this kind of temple a motion in the breast beam, so as to accommodate itself to the motion of the cloth, and to prevent the injuring of the temple, the shuttle, or the cloth, in case of the shuttle being stopped between the reed and the temple."

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32. For a *Fuel Saving House Heater and Cooking Stove,* Josiah W. Kirk and Eli Kirk, city of Philadelphia, August 31.

The object of this improvement, we are told, is to perform cooking, and to heat air for diffusion through the house, by the same fuel. The stove is to be in part of brick and in part of plates of iron. A square wall is to built, three or four inches thick, leaving openings on one side for the grate, ash pit, and an oven. Within this first wall, a second is to be built on three sides, leaving a space between the two, for an heated air chamber. Into this openings are to be made to admit fresh air to be heated, and thence diffused over the house in any convenient way. The walls are all to be built to the same height, and a cast iron plate, with suitable openings for a smoke pipe, to receive boilers, and to discharge the heated air.

The claim made, is, to the combination by which the same fuel is employed for the process of cooking, and for heating air for diffusion in the house, the latter being kept from commingling with the former.

There is little of novelty in this combination, many analogous contrivances having been made; it seems to us, therefore, that the patentees must be confined to their own specified arrangement, as their stove does not possess any distinctive character, to point it out under any considerable change of form. No particular means are proposed for diffusing the heat from the air chamber, and we are very apprehensive that the patentees will find it less diffusible than they anticipate.

Specifications of American Patents.

Specification of a patent for applying spiral or other springs to gigs, and other two wheeled carriages. Granted to Hazard Knowles, *Colchester, New London county, Connecticut, August* 29, 1833.

To all whom it may concern, be it known, that I, Hazard Knowles, of Colchester, in the county of New London, and state of Connecticut, have invented a new and improved mode of applying spiral or other springs to gigs and other two wheeled carriages, by which the bodies of such carriages are allowed to advance forward when the wheels are suddenly checked by any obstruction in travelling, and the unpleasant and injurious effect resulting from the immediate stoppage of the momentum of such carriage, is in a great degree obviated, and the position of the load is so changed in ascending or descending hills as to be more favourable to the draft of the horse. And I do hereby declare that the following is a full and exact description of my said invention.

The spring which I use to prevent the direct arresting of the momentum of the body of the carriage is usually of the spiral kind, which I consider as best adapted to the purpose. This spring is contained within a clasp staple, or other appendage, as shown in No. 1 in the accompanying drawing, which represents the said spring and its clasp, &c. *a a* is a clasp or staple, attached to the draw bar *b b*, containing within it the spiral spring *c c*. The ends of this spiral spring bear against circular caps, with projecting rims to receive them. Through holes in these caps, and also in the draw bar, and in the head of the clasp, passes a slide, No. 2, and having in it a slot, *d d*, of a length equivalent to that of the spring *c c*: For gigs of an ordinary size, the spring may be from eight to nine inches in length, and three inches in diameter; and a slide of twenty-one or twenty-two inches in length will then bear a good proportion to the spring. It may be made round, or otherwise, about three-fourths of an inch in diameter, and the slot about two-tenths of an inch wide. The part *e* embraces the whiffle tree, and is secured to it by a bolt. When the slide passes through the centre of the spring, two keys, or pins, one on the outside of each cap, and having heads on their ends, pass through the slot, and acting on the spring through the medium of the caps, eases the motion of the vehicle in either direction.

The whiffletree, 3, has joints at the ends *f f*, to receive metallic or other rods, 3′, 3′, which may be two feet nine inches long, and must be of sufficient strength to hold back, as well as to draw the vehicle by the forward ends. These rods are bent at the forward ends *g g*, so as to hold the britching, and to hook the traces. The rods may pass either above or under the thills, and through loops of leather bolted to the thills, about four or five inches from the forward ends of the rods.

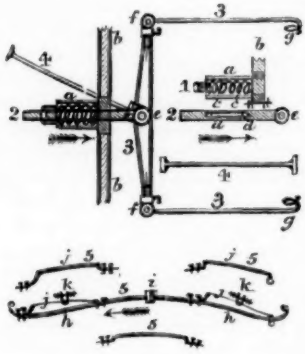
No. 4, is a rod of metal, or other material, extending from the

forked end *e* of the slide, to the under side of the body. Instead of connecting the ends of this bar to the body of the vehicle, and to the whiffletree by iron eyes, I usually employ a loop of leather, strengthened by doubling it: the bolt of the whiffletree passes through one of these loops, and another bolt is used to attach the other end to the body. The load is drawn by means of this rod.

Below the body of the vehicle, I place curved pieces of wood or metal *h h*, No. 5, which rest upon the thorough braces. In a gig which I have in use, these are three feet two inches in length, and in form resemble a cradle spring inverted; they are connected together by a cross bar fastened at *i*. Near their ends are ways of metal *j j*, about nine inches long, resembling in form the pieces *h h*, and firmly fastened to them. Eyes, or staples *k k*, secured to the under side of the carriage body, enable it to slide backward and forward upon the ways *j j*, which they embrace. There are many other methods in which this sliding part may be constructed, but the foregoing will serve as an exemplification of its mode or principle of action.

From the sliding motion of the carriage, the play of the tug strap may not always be sufficient to render the traversing perfectly free, to obviate which difficulty I make the tug staple, upon the thills, longer than usual; but they need not be lengthened in a degree equal to the required play, as the strap itself will answer the intended purpose to a considerable extent.

By the arrangement described, the horse and rider will not only be relieved from the effect of sudden obstructions on the road, but the bearing of the thills and the position of the body and load of two wheeled vehicles, when ascending or descending hills, will be so changed as to be favourable to the draft of the horse.



What I claim as my invention is the manner of employing a spiral or other spring, or springs, so combined with the sliding motion of the body of a two wheeled carriage as to produce the effects described, whether the separate parts be constructed exactly in the way hereinbefore set forth, or in any other operating upon the same principle, and producing the same effects.

HAZARD KNOWLES.

¶ *Report of the Board of Examiners, appointed by the Connecticut River Steam Boat Company, to inquire into the causes of the Explosion of the Steam Boat New England, which occurred at Essex, October 9th,* 1833.

(Concluded from p. 65.)

Testimony of Adam Hall, *Engineer.*

Witness is chief engineer of the establishment of the West Point Foundry association. Made the engine and boilers of the New England. The boilers were 8 feet 4 inches wide, 8 feet high, and about 15 feet long.* Each boiler had two arched flues, and five circular return flues, of 16 inches in diameter.

The arches were made of rolled copper No. 3, wire gauge. The outer shell of No. 4, and the circular flues of No. 5. The boilers were placed one on each guard of the steam boat, at the distance of about 25 feet from the engine. The boilers were strongly braced with $\frac{7}{8}$ inch bolts through the legs or flat sides, at the distance of nine inches, and the arches were secured to the upper parts of the boiler by long bolts of $\frac{3}{4}$ inch copper, with crow feet fastenings. The steam pipes were also of copper, 10 or $10\frac{1}{2}$ inches in diameter, and the safety valve was of the diameter of $10\frac{1}{2}$ inches. The latter was calculated to blow off at a pressure of 20 inches, but the lever was afterwards shortened about 2 feet, and new weights added, after the boat commenced running. There were four water cocks on each boiler, for ascertaining the height of the water.

The lowest of these cocks was three inches above the highest part of the upper flues, and each successive cock was placed three inches higher than the preceding one, the upper cock being twelve inches above the flues. Witness had not proved the boilers. Thinks that the boilers should have borne 50 pounds to the square inch, if there had been no previous imperfection. The strength of copper as compared with iron, is nearly as 3 to 5. The difference, witness says, is above 60 per cent. in favour of iron. Copper has been preferred as a material for boilers because it suffers less from corrosion. Copper is weakened by the action of heat at about 250°. The strength of iron is increased when exposed to heat up to a certain point of temperature. A copper boiler will bear a greater pressure when cold than when heated. An iron boiler, if heated not beyond 450°, will bear a greater pressure than when cold. Has tried experiments with Mr. Stevens on a flat iron boiler, braced at distances of 8 inches with $\frac{7}{8}$ inch brace bolts, at distances of 6 inches with $\frac{3}{4}$ bolts, and at 5 inches with $\frac{5}{8}$ inch bolts. One of the $\frac{3}{4}$ bolts broke at 156 pounds to the square inch. Three of the $\frac{5}{8}$ bolts gave way at 256 pounds to the inch, and the half inch braces stood this pressure without injury. The power was applied by a water press, the safety valve being carefully loaded with an addition of 10 pounds at each trial. Witness thinks, from the appearances of the metal, that the rent of the boilers

* See the figures, page 58.

must have commenced in the arches near their connexion with the after end. Knows Alexander Marshall, and would have no hesitation in trusting him with the care of an engine in any case. Witness employed him to take charge of a high pressure engine last winter.

Testimony of HENRY WATERMAN, JR., *Captain of the N. E.*

Left New York without working the engine warm, and run the steam down very soon to 4 or 5 inches. The Boston left soon after us, and came up strong till we got through the gate. Then got on 10 or 12 inches of steam, and drew away from the Boston. Might be 1½ or 2 miles ahead at 7½ to 8 o'clock. At this time felt a little alarmed for the labouring of the engine in the heavy sea with 12 or 15 inches. Usually works 14 or 18 inches when in full speed. Was often in the fire room, till half-past 10 o'clock, when he retired. Below Falkner's Island, the wheel rope got foul, which brought him on deck, the boat being in the trough of the sea. Crossed the bar, and got into the river at 1 o'clock, it being low water. Made two attempts to land at Saybrook, and failed, owing to there being no one to fasten a line on shore. Anchored in consequence of a difficulty in moving the valve rods, and blew off the steam. Observed the fireman pumping up one of the boilers, and ordered others to assist him. Examined the water in the other boiler and found it sufficient. When the engineer was ready, got under weigh immediately, and went to the wharf. Heard no complaint of the boat behaving worse than common. Saw nothing unusual or alarming. Carried less steam in the Sound than usual on account of the heavy sea. Should have carried from 12 to 18 inches had the water been smooth. Had a favourable passage, excepting the heavy sea. Did not notice the state of the steam after leaving Saybrook. Had no apprehensions or fears of any kind at that time, and had heard none expressed by the passengers or other persons on board. Had full confidence in the perfection and strength of the boilers and machinery. This confidence was derived from the experience we had already had. Witness has been five years in the steam-boat business, and has had charge of a boat for the last three years. Was making no unusual exertions to reach Hartford early, and felt no inducements to such a course.

Has accidentally fallen in company with other steam-boats since he had run the New England, and has not been able to keep as much steam while so in company, as was desirable, the boilers being too small for the engine, and could not on an average in these cases keep more than thirteen inches. Six persons were blown overboard by the explosion, of whom two were drowned.

Witness is not able to form an opinion as to the immediate cause of the accident.

Testimony of Mr. SAMUEL M. HAYDEN.

The witness lives at Essex, above twenty-five rods from the spot where the disaster occurred. Heard the steam when the New Eng-

land arrived at Essex, the noise of which continued while the boat was landing. Witness doubts if it was three minutes from the time he first heard the steam, till the explosion took place.

His first knowledge of the arrival of the steam-boat was from hearing the steam. There were two distinct explosions, following very closely, and "lapping on to each other." The last explosion appeared to be the sharpest. Fifteen persons have died, including those whose bodies were found in the river.

Such is the evidence which was submitted to our consideration. It was also testified by one of the firemen, that the *damper*, by means of which the fire is held in check, was not closed during the stop at Essex, a fact which has not been recorded in its proper place. We consider it a remarkable fact, as well as an important circumstance in respect to the success of our investigation, that we have been able to obtain the testimony of the engineers and firemen who were on duty at the time of the explosion, all of whom were providentially saved. This has relieved the case from much of that obscurity which has rested on other disasters of this kind, where those immediately in charge of the boilers and engine, have been the principal sufferers.

We annex sketches of the longitudinal and cross sections of the boilers of the New England, reduced from the original drafts from which the boilers were constructed, which will serve to illustrate the foregoing descriptions. (See figures, page 58.)

The various theories and conjectures which have been put forward to account for this disaster, may be comprised under the three following heads.

1. The production of some *gas*, (probably hydrogen,) suddenly evolved in great quantity.

2. A supposed injurious *heating of the water legs*, (*d d d* fig. 2,) and lower parts of the boiler, in consequence of the water being driven by the steam into the upper part of the boiler, and perhaps causing a rapid production of steam on its return to the heated metal.

3. A *deficiency* at the time of the accident, *in the quantity of water* which it is necessary to carry in the boilers, owing to the carelessness of those in attendance, or to their being deceived in their examinations of the water cocks. It has been supposed that the metal of the boilers may thus have been weakened by heat, or that the sudden suffusion of water on the metal thus heated, occasioned by the sudden discharge of steam at the safety valve, may have generated steam in such quantity, and in a manner so instantaneous as to destroy the boiler.

4. *Stress of steam* accumulated beyond what the boilers were able to sustain.

1. *It is supposed by some that the explosion was produced by gas.*

On this suppositon we may remark, that upon our arrival at the scene of the disaster, we found this to be a favourite hypothesis with

a number of sensible and reflecting men, who were so strongly impressed with the energy of the force requisite to produce so powerful an explosion, that they were disposed to look for some extraordinary cause. We cannot, however, see grounds for adopting this view. Even in the case of iron boilers, heated red hot, we believe that the production of hydrogen gas in any such quantity as to cause the explosion of a boiler, has never yet been proved, although it is undoubtedly true that iron thus heated has the power of decomposing water and evolving hydrogen gas; and the gas, when thus liberated, would, indeed, act as a force auxiliary to the steam; but the decomposition, and consequent production of hydrogen, would have its limits from the oxidation and cooling of the iron. Steam has never been decomposed by heat alone. Water yields up its elements, oxygen and hydrogen, to electricity, especially to galvanic electricity, but not to simple temperature, however high. Heat requires to be aided by the attraction of some substances which will remove the oxygen, and thus liberate the hydrogen. Copper cannot do this, even at a white heat. Copper thus heated would produce a great abundance of steam, but no inflammable gas.*

In the boilers of the New England, there was no iron: all the pins, bolts, and rivets, were of copper. There were, indeed, a few square feet of iron plate in the chimnies, to which the steam had access on one side, and there can be no doubt that these flues frequently became red hot. The surface exposed to the steam is, however, soon oxidized by the vapour, especially that from saline fluids, and must then become incapable of decomposing water.

Granting, however, that in the case before us, this decomposition did take place to a certain extent, the hydrogen gas, being the lightest body known, would not descend into the boiler, but would pass on into the steam tube, and into the cylinder. Here, indeed, it might, to a degree, repress the strokes of the piston, being itself uncondensible; but it would ultimately pass into the condenser, and be thrown out into the atmosphere through the air pump. Its production, if it ever happen would be confined to a few days when the chimney was new, and the quantity would be too small to be of any importance. Since hydrogen gas, when mixed with a certain quantity of air, and ignited, has the property of exploding with violence, it has been sug-

* Copper will pass, in a melted state, and at a white heat, through a high column of water, and remain for some time ignited at the bottom of the vessel. Heated copper generates steam with great rapidity. According to the statement of Mr. Adam Hall, ten pounds of copper heated to such a degree of redness as to be merely visible in the dark, will convert a pound of water into steam, making more than twenty-seven cubic feet at the common atmospheric pressure. It follows, therefore, that copper flues having, on the whole, an extensive surface, and great weight, may produce an uncontrollable quantity of steam, even at a heat far below redness. This fact suggests an additional reason, if any were necessary, why the water should be most anxiously guarded from falling below the top of the flues. (See the valuable experiments of Professor Johnston *on the comparative quantities of steam produced by heated metals*, in the American Journal of Science.)

gested, that its agency in steam-boat explosions is due to this property, and not to its acting simply as an auxiliary to the pressure of the steam. A volume of common air equal to several volumes of the hydrogen present, would be required to render the mixture explosive; but we know of no source whence such a quantity of common air could be supplied. We therefore conclude that, in the actual circumstances, neither hydrogen gas, (nor, as we believe, any other gas,) can ever aid in the explosion of a steam-boat boiler, except simply by adding just so much elastic power as the same volume of steam, at the same high temperature would produce, and no more.

2. *Others ascribe the explosion in question to an over heating of the water-legs of the boiler.* We have no proof that metal can be thus heated while under the superincumbent pressure of a body of water, with a fire of pine wood as used in these boilers. It ought also to be objected that the water-legs are, for the most part, near to the bottom of the flues, and are therefore less exposed to the action of the fire than the arches and higher parts of the boiler. No difficulty of this kind is known to occur in other boilers of like construction. In the boilers of locomotive engines, a strongly heated blast is driven through copper flues placed in contact with a much smaller volume of water, under circumstances which are vastly more suited to produce the supposed effect, and yet these boilers are used with safety. We cannot, therefore, ascribe the explosion to this cause.

3. *By others the explosion is ascribed to deficiency of water.* To this cause, all disasters of this kind, are usually ascribed, and there is, perhaps, a prevailing disposition among practical men to account for them in this manner. That there is always some hazard from this source attending the use of steam boilers, especially those of ordinary strength, is undoubtedly true; and in the absence of all evidence in the case, it might be proper to resort to this as the most probable conjecture. But it would be folly to adopt this opinion, when contrary to all the evidence, and especially so in a case where adequate cause could be shown without resorting to this hypothesis. To insist, in all such cases, as has too often been done, that this is the true and only cause of these disasters is, as we fear, but too likely to perpetuate their occurrence; for so long as this opinion is cherished, the security afforded by an increased strength of the boilers is likely to be neglected. The tremendous exertion of force in the case under consideration, has been urged as evidence that the explosion was of this character, but, as we think, without sufficient reason. The aggregate expansive force upon the whole internal surface of each boiler could not have been less than 3,000,000 pounds, which must be acknowledged to be adequate to the effect produced. Besides this, we have noticed that the great external arch and outer shell of either boiler, was not torn asunder, except as it was separated from the ends and the inner shell, and this part of each boiler now constitutes one extensive but unsightly sheet of copper. The upper flues, too, with their connecting parts, as also the steam chimney, have received no injury: which facts appear unaccountable, if the

case was of that highly explosive kind which has been supposed. The explosion of both the boilers, at almost the same instant of time, has also been urged in support of this hypothesis, but we do not see that any confirmation can be derived from this fact; for it is known that the two boilers were supplied from different pumps, were entrusted to the care of different hands, and were in these respects entirely independent of each other. It is therefore not probable, to say the least, that both the boilers should become fatally deficient in their supply of water, at exactly the same time. And furthermore, it does not appear that any sudden relief was given to the boilers, either by raising the safety valve, or starting the engine, which in case of such scarcity of water could have caused it to rise suddenly upon the heated metal in the manner supposed. In view of all the circumstances of the case, and of the ample evidence afforded by the present state of the metal and the testimony of the witnesses showing that the boilers were well supplied with water at this time; we reject this supposition as altogether indefensible.

4. We are therefore constrained to adopt the remaining conclusion, and give it as the unanimous opinion of the Board of Examiners,

That the explosion of the steam-boat New England, was caused by the pressure of steam, produced in the ordinary way, but accumulated to a degree of tension which the boilers were unable to sustain.

It apears that the boat started from Lyme, very strongly, under the head of steam which had accumulated while landing at that place: that immediately after, the pilot found it necessary to order the steam to be shut off from the engine in order to facilitate the steering of the boat, that the steam continued shut off (throttle valve closed, or nearly so,) during the greater part of the passage from Lyme to Essex, a distance of three or four miles; that when the boat arrived at Essex, there was, by the firemen's gauges, a pressure of about twenty-six inches; (equal to a column of fifty-two inches of mercury, or near twenty-six pounds to the square inch;) that the safety valve was not raised to blow off the steam while the boat stopped at Essex; that previous to the explosion, the float rod of one of the gauges had risen to the boiler deck, a height of twenty-eight inches; according to Mr. Potter's admeasurement, and that this pressure was rapidly increasing; while on no former occasion, had it been known to exceed twenty four inches.* As the mercury remained in two of the steam gauges, the greatest pressure must have been less than thirty-two inches, and we conclude that the steam was allowed to accumulate nearly, or quite, to thirty inches, and that at this juncture the weakest part of one, or both, the boilers gave way, tearing the adjacent parts asunder, breaking in rapid succession the nearest brace bolts, and involving all else in one sudden and common ruin. The noise of the steam previously heard on shore by Mr. Hayden, appears to us to have been the natural discharge of surplus steam by the safety valve, beyond what the weights would confine, as in the case of twenty-four

* By the gauge in the engine room.

inches pressure, mentioned by Mr. Potter. This partial blowing off, which indicated great pressure, does not appear to have been particularly noticed by the engineers, or other persons engaged in active duty at the time. It is true that the amount of pressure proved by the two firemen, was not so observed by the engineers; but Younger tells us that he did not see the engineer's gauge while at Essex, and furthermore that he could not see it while standing at his post; and it is conceived that Marshall, in the obscurity of night, and while assiduously engaged in his other duties, might easily mistake, or overlook, the movements of so small an instrument as the gauge rod.

An almost simultaneous explosion of two boilers, may probably be accounted for by considering that they were as nearly as possible of the same strength, and were necessarily subject to the same pressure; or we may reasonably suppose an instantaneous impulse or concussion to have been communicated from the first boiler to the second, while the latter was strained to the extreme limit of its strength.

Our conclusion may perhaps be met by Mr. Hall's opinion, that the boilers would have sustained a pressure of fifty pounds to the inch, provided that every part was sound, and bore its proper share of the strain. But with all due deference to this opinion, we must still think his estimate a great deal too high; and it does not appear that a copper boiler of this description has ever been proved to such an extent. We learn from the experiments of Guyton Morveau, that the tenacity of iron as compared with copper, is nearly 549 to 302, showing a difference of more than 80 per cent in favour of iron. Now if we make our estimate from the pressure at which these boilers are supposed to have given way, they would, if constructed of iron of the same thickness, have sustained a pressure of about fifty-four pounds to the square inch; which, in our view, is more than twice the pressure that a prudent engineer would have carried upon them. It is believed, also, that the actual strength of these boilers, as compared with those which are usually constructed for steam of high pressure, will fully justify these conclusions.

Reports have been in circulation, that the explosion of the New England was occasioned by *racing*; but after careful investigation, we see no reason to connect this accident with any supposed competition with other steam-boats.

As regards the bearing of our conclusion, we do not feel it necessary to attach any high degree of blame to those who were in the charge of the boat and engine, at the time of the accident; and they may justly be exonerated from any charge of voluntary or wilful misconduct. Their leading error, or fault, seems to have been, too much confidence entertained by them in the security of the boilers, strengthened perhaps by too little acquaintance with the management of engines of this powerful kind; by which means they may have been led to disregard, or overlook, the rapid production of steam which is necessary to such engines. It seems necessary, in managing boats of this description, to close the damper of the chimney, and

to open the safety valve, immediately when a stop is made, and to continue these precautions so long as the detension shall exist.

The Board of Examiners are fully and unanimously of the opinion, that in the construction and management of this boat, the steam-boat company used their best endeavours for the accommodation of the public, and committed the navigation of it to persons of established reputation for prudence and skill in their profession.

The proprietors of the New England, appear to have spared no expense in procuring a safe and efficient steam-boat for the conveyance of passengers; and the disappointment and deep regret resulting from this sad catastrophe, is doubtless more largely shared by them than by the great mass of their fellow citizens. Perhaps one of the remote causes of the disaster may be found in their desire to satisfy the wishes and expectations of the public, in furnishing copper boilers for the New England as well as for the Oliver Ellsworth, after the failure of an iron boiler, which was formerly used in the last named boat. It may be presumed that copper boilers will be less likely to be preferred hereafter, especially for steam-boats in which the late improvement of working the steam expansively has been adopted.

The great practical object aimed at in this inquiry is to promote by any practicable means, the future safety of passengers travelling in steam-boats. It is not sufficient that the number of these accidents, as compared with the increased number of steam boats, is gradually lessening, or that this mode of travelling is even now safer, on an average, than any which is afforded by the ordinary method of conveyance. Much yet remains to be done by way of affording additional security.

The great advantages which result from working steam expansively are such as to preclude the idea that it will ever be abandoned, and it is beginning to be adopted in the British steam-boats. But we think that the owners of our steam-boats are imperatively called upon to adopt a stronger form of boiler for engines of this description. Experience has shown that when the form of the boiler is perfectly cylindrical in all its principal parts, and of small diameter, that even a rent in the boiler, or an absolute deficiency of water, is but seldom attended with calamitous results; while the great range of strength beyond the ordinary pressure of steam, which such boilers possess, precludes the accumulation of pressure to a dangerous point by any of the ordinary detentions or casualties. It is now known that circular flues can be constructed of a very small size with increasing safety and advantage, and we confidently expect that a combination of parts can be made upon the principles here recommended, which shall furnish steam sufficient for the supply of the largest engines; while the degree of safety shall be so much increased, as will reduce the hazard of travelling in steam-boats to an almost inappreciable ratio; and while our rivers shall be navigated by these wonderful vessels, one of the highest gifts of art and civilization, and our plains be traversed by the unrivalled speed of the locomotive, it is hoped that we never may

have occasion to lament such a melancholy disaster as that which has occasioned our present labours.

B. Silliman,
Professor of Chemistry, &c., Yale College.
W. C. Redfield,
Engineer, and Agent of the Steam Navigation Co. of New York.
Denison Olmstead,
Professor of Natural Philosophy, &c., Yale College.
Daniel Copeland,
Engineer, and Manufacturer of Steam Engines, Hartford.
John F. Lawson,
Engineer of the Steam-boat Chief Justice Marshall.

New Haven, November 27th, 1833.

Proofs relating to Mr. Woolf's Invention of applying High Pressure Steam Expansively.

(Continued from p. 55.)

In 1816, an entire new engine was made at Dolcoath mine, by Messrs. Jeffery and Gribble, to work with high pressure steam acting expansively, on Mr. Woolf's system, in one cylinder of seventy-six inches diameter; it answered extremely well, although it never did so much as the engines with two cylinders had done, whilst they were new and in good order; but as they materially fell off in 1817, and 1818; when they got out of order, and as the Dolcoath engine kept up a steady performance of about forty millions, the use of one cylinder for Mr. Woolf's system obtained the preference; and in a short time after Mr. Woolf's patent expired, most of the old Boulton and Watt's engines in Cornwall were altered to work by high pressure steam on his system; some few had an extra cylinder added, but commonly the old cylinder was retained. The advantage of the change from low pressure to high pressure, on Mr. Woolf's system, was manifest in all cases; but it was greater or less, according as the steam was used stronger, and with more or less expansive action.

All the new engines since erected in Cornwall have been made expressly to work on Woolf's system, and always with one cylinder, excepting one instance of two cylinders. In 1820 Mr. Woolf made two engines for the Consolidated mines, each with one cylinder ninety inches diameter; but as neither of those, nor the Dolcoath engine, ever did so much as the engine with two cylinders had done at first, Mr. Woolf still felt inclined to prefer his original plan. Accordingly in 1824, having undertaken to make two large engines at Wheal Alfred, he prevailed on the adventurers to go to the expense of making one of them with two cylinders, of forty and seventy inches diameter, the other engine being the same as those at Consolidated mines, with one cylinder ninety inches diameter; both engines were worked with high pressure steam. The performance in 1825, averaged 40.01 millions with two cylinders, and 42.15 with one cylinder: this was

considered decisive against two cylinders;* and no engines have since been made in Cornwall, either by Mr. Woolf or others; except with one cylinder, to work on his system.

The performance of those engines was very slowly and gradually increased, as appears by the following annual averages of the highest performances that are to be found amongst them each month. Until 1826, their performance remained below that of the first engines with two cylinders, in 1816, which then averaged 46.97 millions. Previous to 1826, the steam cases of the cylinders were not clothed, but exposed to the air.

Years.	Millions.	Years.	Millions.
1816	36.3	1823	42.1
1817	41.6	1824	42.5
1818	39.3	1825	45.4
1819	40.0	1826	45.2
1820	41.3	1827	59.7
1821	42.8	1828	77.3
1822	42.5	1829	76.2

The advance made in 1827, and since that time, has been effected by good management of the engines, chiefly by clothing all the steam vessels, and thus preventing any needless waste of heat by radiation; also by using better boilers;† but the engines are strictly according to Mr. Woolf's system of high pressure acting expansively in one cylinder.

Great credit is due to Captain Samuel Grose, who began the race of improvement in management; first, in an engine which he made at Wheal Hope, in 1825, and still more in another which he made the next year at Wheal Towan, with an eighty inch cylinder; in 1827, it averaged 58.18 millions, its highest being 62.22 in July.

At the end of 1827, Mr. Woolf removed the ninety inch cylinder engine before mentioned, at Wheal Alfred, (that mine having ceased working,) to the Consolidated mines, and by good management and clothing, it raised 64.42 millions on the average of the last three months, the highest being 67.10 in November.

In 1828, Captain Grose brought the annual average performance of Wheal Towan engine to 77.29, the highest being 87.05 millions; in

* The engine with two cylinders had boilers on a complicated plan, which did not answer well, and the other engine had very good boilers. If both engines had been worked with equally good boilers, the two cylinders would have made the best performance.

† See Mr. Taylor's paper on these boilers, Phil. Mag. and Annals, N. S. vol. i. p. 126; they are long cylinders, containing cylindrical tubes within them for the furnaces; on a plan which was first brought into use for high pressure steam by Mr. Trevithick, in 1804.

April,* Mr. Woolf's engine averaged 62.57, and its highest was 67.56 millions in May. These striking examples stimulated the exertions of all the Cornish engineers to take the same care in management, and with such success that the average of all the engines in 1829, was 41.22 millions; although in 1814, before Mr. Woolf's system was begun, it was only 20.37, or less than half. The number of engines, and the power exerted by them, is more than doubled, whilst the quantity of coals consumed by them is sensibly lessened.

The importance of such an increase of power from the same fuel, to the success of mining in Cornwall, may be estimated by the following account of the Consolidated and United mines, which are worked by one company of adventurers, and form the largest mining establishment in existence.

The United mines are worked to a loss, and are only kept drained to about one-third of their depth, in order to cut off some water which would otherwise flow into the Consolidated mines. These mines have been more productive during the last seven years, than the average of mines in Cornwall. The following particulars are collected from the accounts which have been printed annually in a series of reports by Mr. John Taylor, and from the monthly reports on the engines.

The Consolidated mines recommenced working in 1819, after laying drowned for fourteen years, and 65,000*l.* was advanced by the new adventurers, to bring them into operation. During the years 1819, 1820, and 1821, the expenditure exceeded the returns by 74,078*l.*; but during the years 1822, 1823, and 1824, a profit of 51,561*l.* was made.

At the end of 1824, 10,000*l.* more was subscribed to continue the United mines, which were given up by their original proprietors. The capital to be repaid to the adventurers at the beginning of 1825, including interest then due upon the several advances, was 55,382*l.* During the last five years, the Consolidated and United mines together have produced a profit of 63,604*l.*; whereby all the capital subscribed, together with interest upon it, has been paid off, and an actual gain was made in 1829, in addition to the value of the stock of materials on the mines.

The total expenditure in all the eleven years, has been 824,585*l.*, and the returns 865,672*l.*; hence the profit beyond the repayment of the capital subscribed, has been 41,087*l.* in eleven years; or interest at five per cent. per annum being allowed on the sums subscribed, until the periods of repayment, the clear gain is stated, in the printed accounts, to be only 10,244*l.* to the adventurers.†

The expense of draining the water from both mines, as stated in

* See Mr. John Taylor's account of the performance of this engine in May, 1830, when, on an accurate trial of about two hours and a half working, it raised 92.33 millions.

† This does not include any valuation of the materials in use in the mines, although the cost of all materials is included in the amount of total expenditure. The materials would sell for a large sum, but that can scarcely be reckoned as a part of the profit, because from the uncertainty of mining prospects, a mine cannot be given up in time to realize it: the working is usually continued at a

the annual accounts for the last five years, has been decreasing each year from 17,776*l.* to 11,958*l.* per annum; although the monthly reports on the engines show that the number of engines has been increased from four to eight, and the power exerted by them increased from 432 to 513 horse power. The cost of drainage has averaged 13,826*l.* per annum. The average performance of the engines has been improved from 30.04 to 51.81 millions, during the last five years, averaging 39.36 millions; being more than double 19.38 millions, which was the average performance of Mr. Watt's engines in 1813, when Mr. Woolf went into Cornwall; therefore, if such engines were now used at the Consolidated mines, the expense of drainage might be expected to average (13,826*l.* × 39.36 ÷19.38 =) 28,100*l.* per annum, or 14,274*l.* more than it has been; and it is that saving which has constituted the whole of the profit during the last five years.

During the last five years the mines have produced 73,561 tons of copper ore, which on an average has yielded nine and a half per cent. of copper, and thirty-six and a half tons of tin ore. The ores have been sold for 548,872*l.*, of which one twenty-fourth has been paid to the lord of the soil as rent. The total cost of working the mines has been 426,444*l.*, leaving a clear profit of 63,604*l.*

The above is but a limited view of the advantages arising from the use of Mr. Woolf's engines; for if the mines had been begun in 1819, with Mr. Watt's engines, the loss during the first years would have been considerably greater than it was, and the mines would have continued to be unprofitable for a longer time than three years; also the subsequent profit would have been so much smaller than it has been, that it would not have repaid the previous loss (and interest upon the capital advanced) for a long time to come, beyond the present date, supposing the mines to continue to yield ore. In fact, if these mines could have been worked with profit by Mr. Watt's engines, they would not have been given up as they were, twenty-five years ago, when they were not worked out so deep, or so extensively, as they are now.

Engines and cost of drainage at the Consolidated and United Mines.

Date.	No. of Engines	Horse power.	Average Millions.	Cost of drainage.	Clear profit.	Expense saved.
1825	4	432	31.04	£17776	£4169	£9824
1826	6	422	32.31	13543	7648	8337
1827	8	378	36.76	13426	13294	11254
1828	8	526	44.86	12428	22314	15452
1829	8	513	51.81	11958	16179	19042
Avers.	7	454	39.36	£13826	£12721	£12782

loss until a debt is incurred, and when the adventurers become too much discouraged to make further advances, the mine is given up, and the materials sold to pay the debt.

The last column of the table shows the saving that has been made by the use of Mr. Woolf's engines, or the increase in the cost of drainage that would have been incurred by using Mr. Watt's engines, raising twenty millions, instead of the engines actually used; those savings are included in and form part of the profits, and without them the extra expense would have absorbed more than all the profit in 1825, 1826, and in 1829, so that instead of profit the adventurers would have lost 5,655*l.* in 1825, 689*l.* in 1826, and 2,863*l.* in 1829. Or, taking the whole of the last five years, no profit would have been made; and it would have been more advantageous to the adventurers to have broken up their establishment, and sold the materials, than to have continued working.

In conclusion, it may be safely asserted that the saving in fuel resulting from the general use of Mr. Woolf's system of working steam engines by high pressure steam acting expansively, (instead of Mr. Watt's system of working them by low pressure steam acting expansively,) constitutes the present profits of deep mining in Cornwall.

JOHN FAREY.

London June 5, 1830.

[*Rep. Pat. Inv.*

An Anti-Sediment.

The substance employed here (Craighall Colliery,) is known by the name of *comings*, being the radicles of barley, produced in the process of malting, which are separated before the malt is sent to market. About a bushel of these is thrown into the boiler, and when the steam is again raised, an immediate effect is visible, for there is not only a plentiful supply of steam to produce the full working speed of the engine, but an excess of it is going to waste at the safety valve. This singular effect will continue several days. Such is the fact; but the principles by which the vegetable matter acts are not very obvious, as it is doubtful whether it acts chemically or mechanically; if its action is mechanical, chaff or saw dust may produce the same effect.—*Milne's Practical View of the Steam Engine.*

[*Mech. Mag.*

The Iron Steam-boat Alburkha.

This vessel is now in the river Niger, with the Quorra steam-boat, and seems to have been the favourite of the two vessels since they departed on their interesting expedition. The advantages of iron vessels in warm climates, are ably pointed out in a short extract we gave in our last number from Chambers' Journal; and these advantages seem to be in no wise exaggerated in the instance of the Alburkha.

according to the reports received from those embarked in her. This vessel was built by Mr. Laird, of Liverpool for the purpose of navigating the shoal water of the river, and we understand that he has since constructed another for the interior navigation of Ireland. We have no doubt that these vessels from their vast superiority over those of wood, and their durable quality, will speedily be numerously employed. [*Nautical Magazine.*

Cast Iron Beams.

In the early application of cast iron beams, it often happened that a beam broke without any apparent reason; and it was ultimately discovered that slight vibrations, or constant slight shocks, had the effect of breaking even heavy beams; this lead to the application of a soft material placed under the parts of the beam, where supported by masonry, which, acting as a damper to vibration, proved of great utility in preserving cast iron beams. The cast iron chairs which receive the rails for railroads, have been found to break in a similar manner, and in some instances of late, a piece of felting, made of ox hair, and consequently indestructible, has been placed between the stone sleepers and the chairs, which has produced a most advantageous result.

[*Rep. Pat. Inv.*

¶ POPULAR SCIENCE.

No. VII.

On the Instincts of Birds. By JOHN BLACKWALL, *Esq. F.L.S.*

[Continued from p. 72.]

The habits and manners of birds are sometimes so greatly modified by the exercise of the intellectual faculties, that, in many cases it becomes extremely difficult, if not impossible, to determine what is due to their influence; but that no small portion of intelligence is exhibited in the following instances will scarcely be denied.

The white headed eagle, and several of the gulls, which prey upon the finny inhabitants of the waters, frequently save themselves the trouble of fishing, by robbing their more expert and less powerful congeners of the fruits of their industry, occasionally compelling the objects of their violence even to disgorge their undigested food.

The pied and yellow wagtails run close to the legs and noses of cattle which are grazing, in pursuit of the insects disturbed by them. The same motive also induces these and many other birds to follow the husbandman, when he is busy with the plough or harrow; and the redbreast attends the gardener in his labours, and siezes the worms which he turns up with his spade.

Mr. White states,* that the great titmouse, in severe weather, fre-

* Natural History of Selborne, p. 106.

quents houses; and in deep snows, as it hangs with its back downwards, draws straws lengthwise from the eaves of those buildings which are thatched, in order to pull out the flies that are concealed between them; and I have seen hooded crows, on the eastern coast of Ireland, after many unavailing efforts to break with their beaks some of the mussels on which they were feeding fly with them to a great height in the air, and by letting them fall on the stony beach, fracture their shells, and thus get possession of the contents. Perhaps it would not be easy to select a more striking example of intelligence among the feathered tribe than this, where, on one expedient proving unsuccessful, after a sufficient trial had been made of it, another was immediately resorted to.

Chickens, in their early attempts to catch flies and other winged insects, show little or no address, but repeated failures teach them to use more circumspection; and they soon learn to distinguish between an active vigilant prey, and the inanimate substances on which they likewise feed. This cautiousness of proceeding is clearly the effect of information obtained by experience, and affords an example of instinctive power being excited to activity by the intellect; but a still more extraordinary instance of acquired knowledge is given by Montague in the Supplement to the Ornithological dictionary. This gentleman observed two crows, by the sea shore, employed in removing some small fish (the refuse of a fisherman's net,) from the edge of the flowing tide. They carried them, one by one, just above high water mark, and there deposited them under large stones, or broken fragments of rocks, after having amply satisfied the immediate calls of hunger. Now it must be conceded that these birds were aware, that the advancing flood would sweep away their prize, unless they conveyed it beyond the limit of its usual rise, or their conduct is quite inexplicable. It is equally plain that this knowledge, in the practical application of which they manifested so much foresight and sagacity, could be derived from observation and experience only; because, if it originated in a blind instinct, it would be common to every individual of the species, and consequently often displayed; whereas, although I have seen hundreds of crows feeding in situations similar to that above described, I never perceived any of them resort to this effectual means of preserving their prey from the encroaching waters, and I believe the instance related by Montague is solitary in the records of ornithology.

This propensity to hide the food it cannot devour is not, however, peculiar to the crow. I have noticed it in the raven and magpie; and rooks, in the autumn, frequently bury acorns in the earth, probably with the intention of having recourse to them when their wants are more urgent; but, sometimes, forgetting where they have concealed them, they germinate, and not unfrequently excite surprise, by the singularity of the situations in which they grow, far distant from any trees by which they could have been produced, and where it is very evident that they have not been planted by man.

It may be proper to remark here, in order to obviate misapprehension, that, notwithstanding the circumstances attending this seeming-

ly provident mode of securing a supply of food against a future occasion, sometimes afford unequivocal evidence of an intelligent and discerning agent, yet the act of hiding is induced by a purely instinctive propensity. This will be admitted by every one who considers that the species of birds which are remarkable for this peculiarity, practise it, however well they may be fed, when brought up in a state of domestication.

In addition to the numerous proofs of the intelligence of birds already given, I may mention their susceptibility of receiving instruction by education. Thus eagles, falcons, and hawks, have been trained to limit the effects of their instinctive propensities to kill, to a particular species of game; and to return to the call and line of the falconer, after having struck down the quarry. The cormorant, too, was formerly employed with success in taking fish. Here, then, not only great attachment to their keepers, and much docility of disposition, are evinced by birds which are naturally wild and voracious, but a considerable share of memory is displayed, and a surprising degree of control exercised, over some of their most active instincts.

Several birds of the finch, grosbeak, and warbler genera, acquire the art of piping long and difficult tunes with facility and precision; and it is well known that some of the parrots, and also the jay, starling, jackdaw, and magpie, readily learn to pronounce single words, and even short sentences, with considerable exactness. Yet, although I have excellent opportunities of observing the last species, and have been almost in the daily practice of investigating, I never knew it display any unusual exertion of its capacity for imitation in a state of nature, though, when domesticated, it appears to have this faculty more highly developed than almost any other British bird.

The congregation of gregarious birds, which takes place in the autumn, when they have finished breeding, is perhaps intended to promote their mutual security, as they are much less liable to be surprised by enemies, when associated together in large numbers, than they are when separate. What tends to strengthen this opinion, is the fact, that some species provide for the general safety, by appointing sentinels to give notice of approaching danger. This social disposition, which (with the well known exception of rooks) usually continues no longer than the next pairing season, seems, from the uniformity of the actions that result from it, to be of instinctive origin; though it certainly would be difficult to bring any direct proof that such is the case.

In treating of the migration of birds, Dr. Darwin observes, that as all species are capable of remaining throughout the year in those countries in which they were bred, any departure from them must be unnecessary, and therefore cannot be instinctive. This reasoning, however, is extremely fallacious, inasmuch as it restricts the operations of instinct solely to what is necessary; whereas, we have seen that the singing of birds, and the practice of concealing their superfluous food, though not absolutely indispensible, are, nevertheless, decidedly instinctive. It is, moreover, built on the gratuitous assumption, that several of the periodical summer birds, as the swallow, flycatcher,

cuckoo, goat sucker, &c., which feed almost entirely on insects, and consequently would not be able to procure a sufficient supply of nourishment in the winter months, have the property of passing the cold season in a state of torpidity; an hypothesis directly at variance with well established facts. Indeed how very defective and unsatisfactory the arguments advanced in support of the hybernating system are, does not require insisting upon, as those who have considered the subject impartially, must be well aware, that they are almost wholly founded on the heresay reports of ignorant and credulous persons.

The history of the cuckoo proves most incontrovertibly, that the propensity to migrate in this species is instinctive, since nearly all the young ones brought up annually in the north of Europe, quit it without receiving the least instruction that such a proceeding is requisite, and without any guide to direct them in their novel undertaking. But I forbear to dwell on the instincts of this extraordinary bird, partly on account of their being so very anomalous, but chiefly because I have considered them at length on a former occasion.* The highly curious fact that the swallow, house-martin, sand-martin, and puffin, sometimes leave their last hatched brood to die of hunger in the nest, in order to accompany their species in their autumnal migration, is alone sufficient to establish the instinctiveness of that inclination which can thus overcome their parental affection,—a feeling so energetic as frequently to counteract one of the most powerful laws of nature, self-preservation. No theory, in short, which is not founded on the opinion that birds of passage, in undertaking their annual journeys, are influenced by an instinctive desire to migrate, liable to be called into action by various exciting causes, can satisfactorily account for the remarkable phenomena which result from this periodical disposition to wander.

The certainty with which the carrier pigeon directs its course towards its accustomed home, from distant places where it has never been before, after every precaution has been taken in its conveyance to prevent it from obtaining any knowledge of the way by observation, must, as well as the act of migration, to which it bears a striking resemblance, be likewise attributed to instinct.

It appears, then, from the foregoing observations, that the principal actions of birds, though liable to be considerably modified by the operations of the intellectual powers and changes of organization, as well as by various external circumstances, are, contrary to the opinion of Dr. Darwin, decidedly of instinctive origin.

Many additional arguments might be advanced, and a multitude of highly respectable authorities quoted, in support of this doctrine; but conceiving that sufficient evidence has been already produced, I shall only add that I am not aware of any serious objection which can be urged against it.—*Memoirs of the Literary and Philosophical Society of Manchester, Second Series*, vol. v.

[*New Ed. Philos. Jour.*

* See observations conducive towards a more complete history of the cuckoo, printed in the fourth volume of the new series of the Society's Memoirs.

CELESTIAL PHENOMENA, FOR MARCH, 1834.

Calculated by S. C. Walker.

D.	H.	M.	S.	
1	6	18	20.1	Em. ♃ 2 Sat.
7	8	7	34.9	Em. ♃ 1 Sat.
8	8	54	6.2	Em. ♃ 2 Sat.
11	1	7		☿ Greatest elong. East 18.°4.
12	6	20	34.0	Em. ♃ 3 Sat.
13	13	9		♃ ☽ ☽ ♃ North 3.°3.
14	10	3	17.6	Em. ♃ 1 Sat.
17	6	11		Im. *o* Tauri, 5, N 90° V290°
17	7	37		Em. *o* Tauri, 5, N112° V339°
19	6	11		Im. 58 Geminorum, 7, N 90° V278°
19	7	10		Em. 58 Geminorum, 7, N 42° V267°
19	8	15	16.2	Im. ♃ 3 Sat.
19	10	22	50.8	Em. ♃ 3 Sat.
21	16			♄ ☌ γ^1 Virginis ♄ South'. 8'.
23	6	27	46.4	Em. ♃ 1 Sat.
23	17	43		♂ ☌ ♅ ♅ North 32'.
24	17	11		♄ ☌ ☽ ♄ South 2.°5.
28	16	15		Im. ♆ Ophiuchi, 5, N189° V211°
28	16	30		Em. ♆ Ophiuchi, 5, N196° V221°
30	8	23	16.4	Em. ♃ 1 Sat.

Remarks on the table of Celestial Phenomena, for March, 1834.

The CELESTIAL PHENOMENA for March, are computed for mean time of that place in Philadelphia, which is 5 hours, 0 minutes, 43.9 seconds west of the meridian of Greenwich, and is in latitude north 39° 56′ 59″. The time is reckoned after the manner of astronomers, beginning the mean solar day at mean noon, and reckoning forward twenty-four hours to the next mean noon.

The phases of Jupiter's satellites are as seen in a telescope that inverts.

The ⁎ with *i* over it, indicates the place of the satellite at immersion.

The ⁎ with *e* over it, indicates the place of the satellite at emersion.

In the lunar occultations, the figure after the star's name denotes its magnitude.

The angles with the letters N and V before them, respectively indicate the point on the moon's limb at which the immersion or emersion of the star takes place as seen in a telescope that inverts; these angles are reckoned westward round the circle; those with N over them from the north point of the moon's disk, those with the V over them from the vertex or highest point of the moon's disk.

These phenomena have been computed from the British edition of

the British Nautical Almanac, a work that should be in the hands of every astronomer.

The lunar occultations of stars of the seventh magnitude have been computed from the elements in the Berlin Ephemeris, this list contains only those visible at Berlin.

The emersions of Jupiter's satellites in this month are marked immersions in the American Almanac for this year, probably from an error of the press.

Meteorological Observations for December, 1833.

Mean.	Days.	Therm. Sun rise.	Therm. 2 P. M.	Barometer. Sun rise.	Barometer. 2 P. M.	Wind Direction.	Wind Force.	Water fallen in rain.	State of the weather, and Remarks.
☽	1	38°	44°	Inches 29.80	Inches 29.80	W.	Moderate.	Inches.	Lightly cloudy—clear.
	2	36	39	.90	.90	NW.	do.		Cloudy day.
	3	35	40	30.04	30.05	E.	do.	0.60	Rain.
	4	37	42	.06	.06	E.	do.		Cloudy day.
	5	39	40	.06	.06	E.	do.		Clear day.
	6	34	43	.10	.15	W.	do.		Cloudy day.
	7	31	42	.00	.20	E.	do.		Rain—Cloudy.
	8	41	44	29.94	29.70	E.	Stormy.	1.90	
	9	31	42	.30	.30	NW.	Moderate.		
	10	32	40	.30	.30	W.	do.		Clear day.
	11	36	37	.80	.80	W.	do.		Clear day.
	12	33	42	.84	.90	W.	do.		Clear day.
⊗	13	32	41	30.00	.85	NE.	do.		Clear—cloudy.
	14	33	30	29.60	.75	NE.	do.	0.25	Snow—stormy.
	15	24	30	30.00	.80	NE.	do.		Cloudy day.
	16	34	39	29.30	.35	NE. S.	Blustering	1.00	Rain—heavy gale—drizzle.
	17	38	37	.35	.40	SE.	do.		Foggy—cloudy
	18	32	40	.80	.90	NW.	Calm.		Cloudy—clear.
	19	25	32	30.00	30.10	W.	do.		Clear day.
	20	25	35	.10	.00	N. S.	do.		Lightly cldy: cloudy: rain in
	21	32	40	29.90	29.90	W. SE.	Moderate.	0.25	[the night.
☾	22	27	38	30.00	30.00		do.		Clear day.
	23	36	35	29.60	29.50	S. W.	do.	0.05	Lightly cloudy: cloudy: rain
	24	36	35	.90	.90	S. W.	do.		Drizzle: cloudy: [in night.
	25	34	36	.80	.80	NW.	Blustering		Fog—drizzle—cloudy.
	26	29	32	.90	.90	W.	Moderate.		Clear day.
	27	24	32	.90	.90	W.	do.		Clear—lightly cloudy.
	28	35	36	30.00	30.00	W.	do.		Clear day.
	29	30	34	.00	.00	W.	do.		Clear day.
	30	34	44	29.90	29.85	SE.	do.	0.15	Cloudy—rain.
	31	34	40	.90	.90	W.	do.		Cloudy day.
Mean		30.50	37.52	29.84	29.84			4.30	Clear day.

Thermometer.		Barometer.
Maximum height during the month,	44. on 1st. 8th. 30th.	30.20 on 7th.
Minimum do. . .	21. on 13th.	29.20 on 9th.
Mean do. . .	34.16 .	29.84